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THE NATIONAL GEOGRAPHIC MAGAZINE

THE AËRIAL CONQUEST OF EVEREST

Flying Over the World's Highest Mountain Realizes the Objective of Many Heroic Explorers

BY LIEUT. COL. L. V. S. BLACKER, O. B. E.

Organizer, Houston-Mount Everest Flight

EVER since it was discovered, in 1852, to be the highest mountain in the world, Mount Everest has exercised a hypnotic fascination for explorers.

The idea of a flight to the mountain is no new one. Many years ago Jules Verne allowed himself to play with the subject. More recently, however, it was revived by Brig. Gen. C. G. Bruce, the famous leader of the early assaults, who, in 1921, proposed to use an airplane. He considered the machine from the point of view of its being an auxiliary to the climbers rather than as the vehicle for the cameras and scientific equipment that would put into concrete form the actual results of an exploring expedition.

Later still, Sir Alan Cobham * pursued the matter practically, and he was followed by both French and German enterprises. Then the reaching of the Poles† and the crossing of the Atlantic‡ and of the Pacific§ left Mount Everest as the most fascinating geographic objective yet unflown.

It was in April, 1932, that I became impressed with the fact that the crest of the mountain might be surmounted, with some degree of certainty, by an airplane, and with the importance of this fact to geographical science.

Although I had given up active flying for a number of years, I had kept in touch with many friends in the world of British aviation and with the general trend of technical progress.

SCIENTIFIC RESULTS ESSENTIAL

It was the activities of the famous Bristol aircraft firm and their wonderful development of the air-cooled radial Jupiter and Pegasus engines which brought matters to a head in my mind. I became convinced that the latest Pegasus, in a suitable airplane, would carry pilot, observer, and a useful load of cameras and instruments to the very great height required and with a reasonable margin.

Without an observer and without fully adequate photographic equipment, the flight would be much easier, but would be mere foolish sensationalism, inasmuch as no scientific results could be expected. As the event proved, this point of view was more than justified.

The project was hardly more than roughed out in my mind when I appreciated the necessity for calling in the coöperation of a first-class administrative organizer.

* See "Seeing the World from the Air," by Sir Alan J. Cobham, in the NATIONAL GEOGRAPHIC MAGAZINE for March, 1928.

† See, in the NATIONAL GEOGRAPHIC MAGAZINE, "The First Flight to the North Pole" and "Conquest of Antarctica by Air," by Rear Adm. Richard Evelyn Byrd, September, 1926, and August, 1930; "Air Conquest," August, 1927; and "Mapping the Antarctic from the Air," by Capt. Ashley C. McKinley, October, 1932.

‡ See "Our Transatlantic Flight," by Richard Evelyn Byrd, in the NATIONAL GEOGRAPHIC MAGAZINE for September, 1927.

§ See "Our Conquest of the Pacific," by Charles E. Kingsford-Smith, in the NATIONAL GEOGRAPHIC MAGAZINE for October, 1928.

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A CHEERIO, AND THEN THE TAKE-OFF!

Lord Clydesdale, chief pilot (left), and the author, who acted as chief observer and operated the mapping, motion-picture, and oblique cameras, await the signal to take the *Houston-Westland* aloft.

Col. P. T. Etherton, a former comrade in arms of the old war times in France and a fellow venturer in the Russian revolutions, proved to be the ideal partner and a tower of strength from first to last.

Three principal obstacles loomed before us: the technical, the political, and the financial.

The supercharged Pegasus engine in a suitable airplane promised to take us over the technical fence, in spite of the fact that it had at that time hardly emerged from the trial stage.

Neither time nor the funds available would allow us to have a special airplane built for the flight, so we had to find one that was already in existence. This was no easy task, because these comparatively large aircraft are seldom built except to the order of governments, which fit them into meticulously arranged programs of reëquipment.

The field was still further narrowed by the fact that we would need a large diameter propeller, hence a big ground clearance, and also by the need for lifting a load which, when oxygen for the long flight came to be considered, was a large one.

Only a few of the otherwise suitable airplanes would take a radial air-cooled engine; and thus several months of inquiry, research, and negotiation passed before we were able to place a definite order. At first we planned to have only one machine, but later we grew more ambitious.

Similarly with the engine, or rather engines. The standard Pegasus proved a noble stand-by, but it had to have a supercharger, which did not happen to be in production in quantity at the time, and a special bevel-gear drive for the unusually big dynamo which we required for our task.

Months of hard work, punctuated with periods of intense anxiety, took us over the technical obstacles at long last.

REMOTE NEPAL RULER APPROVES PROJECT

The political difficulties which confronted us in April, 1932, were so great that many British officials assured us gloomily that we could not hope to surmount them. To reach the summit of the mountain, one must fly either across Nepal or across a portion of Tibet. The latter was out of the question. That vast, remote country is ruled

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THE PERSONNEL OF THE HOUSTON-MOUNT EVEREST EXPEDITION

The two planes, the *Houston-Westland* and *Westland-Wallace*, were housed in temporary canvas hangars at Lalbalu field, on the wide, level plain nine miles east of Purnea, once a city of Mogul splendor (see text, page 138).

by a theocracy of lamas who would not even countenance such a suggestion.

The Government of Nepal is sympathetic to real scientific endeavor, but the Maharaja who rules that beautiful, remote kingdom had to assure himself that our project was sound and serious. If it were not well run, mishaps might take place, forced landings or crashes in lofty ice-bound valleys, entailing complications and embarrassments, political and practical.

At last, thanks to the support of the Royal Geographical Society, all doubts were resolved. Early in June I received an official letter conveying the Maharaja of Nepal's permission for a flight to Mount Everest.

Meanwhile a very influential committee had been formed under the chairmanship of Lord Peel, who had been twice Secretary of State for India. It was not long after this that Lord Clydesdale joined us, with the happiest results for the Expedition, as all the world now knows. Not only had our venturers cause to admire his skill and hardihood as a pilot, but still more cause to be in his debt for his insight and courage in lending the weight of his support to an enterprise that, in its early days, the world considered foolhardy and visionary.

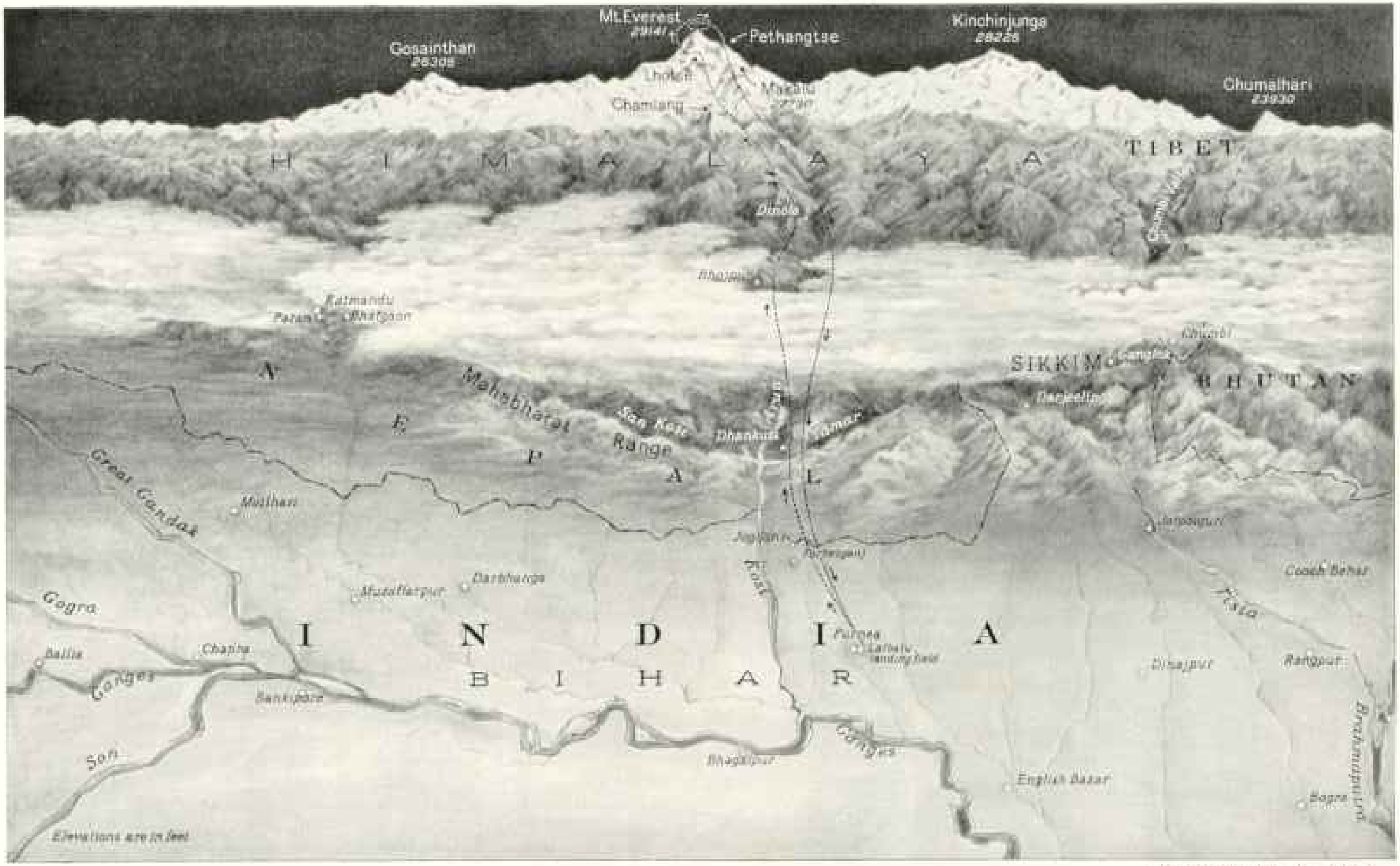
By mid-June, then, the political sanctions had been obtained and an option secured on the necessary engine and airplane.

LADY HOUSTON PATRON OF FLIGHT

But while we had been feverishly at work making secure these two essentials, the third, most essential of all, threatened to slip from our grasp. The world depression had set in, in full force. Various public-spirited benefactors of science were compelled to abate their financial support, and for two or three desperately anxious months the whole Expedition trembled on the brink of disaster.

The three of us upon whom the burden fell were really worn out by anxiety. We held a council of war in our little Chelsea office, grimly totting up the sums we could count upon from here and from there. We could barely make it enough even for a "forlorn-hope" attempt with a single machine.

Suddenly we remembered Lady Houston, that wonderful benefactress of British aviation. Up till then her medical advisers had



Drawn by Hashime Murayama

THE ROUTE AND SETTING OF THE FLIGHT FROM PURNEA, INDIA, ACROSS NEPAL, TO THE SUMMIT OF EVEREST

The diagram gives the general course of the first flight to the world's loftiest mountain. The artist shows the relative location of the political divisions and towns in its vicinity, other mighty peaks of the massive Himalaya chain, and the alto-cumulus clouds over the foothills. Since Purnea is 154 miles distant from Everest, this panorama is foreshortened.

THROUGH THE STRUTS: FROM A DISTANCE EVEREST'S SNOW PLUME SUGGESTS A MAMMOTH VOLCANO

This panorama of Everest and Makalu, framed in the rigging of the *Houston-Westland* plane and rising from a blanket of clouds, was a choice photographic trophy of the second flight (see text, page 157). The length of the plume, as it trails eastward, attests the high velocity of the wind at the summit.

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THE VICEROY OF INDIA INSPECTS THE "HOUSTON-WESTLAND"

The cockpits contained a maze of electric wires for heating and operating the cameras, and for warming the flying suits and jets on the oxygen tanks (see text, page 135). A telephone was installed so the pilot and observer could talk during the flight. After the planes had been assembled at Karachi, they were flown to Purnea, with stops first at Jodhpur and then at Delhi, where His Excellency Lord Willingdon entertained the flyers (see page 142).

prohibited any approach to her, but now the situation was more encouraging. She could receive letters and grant interviews. Unanimously we decided that Lord Clydesdale should write to her. The letter went off that day and met with a quick response.

It was not long before she intimated that her generous purse strings were open unconditionally for the support of the flight. Not only did she, by her munificence, place the flight on its feet, but she followed its interests from first to last with the closest attention.

SEASON OF YEAR IS IMPORTANT FLYING FACTOR

Now our anxieties took a fresh form. We were threatened by the time factor. The ideal season, from the all-important point of view of the weather, would have been November or late October. Until September the violent rains of the Indian monsoon swathe the mountains in impenetrable cloud and mist. In December and January there is again a prospect of short spells of rainy weather and of huge gathering clouds, which are the chief enemies of photography.

Business arrangements dragged on, so that it proved impossible to place orders in time to secure delivery of aircraft and engines until January. However, the orders were placed and checks paid over for the machines and for everything except minor details.

At this point, at the suggestion of the Air Ministry, we were joined by Air Commodore P. F. M. Fellowes, D. S. O., who assumed the post of Chief Executive Officer, to take charge of the actual flying operations. His presence and experience became of high value to the organization, and his status in the Royal Air Force overcame many minor troubles during the period when countless administrative and technical details had to be arranged.

From first to last we received very valuable advice and assistance proffered most cordially by the Air Ministry and by all the establishments of the Royal Air force with which we came in contact. Prominent

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THE CONQUERORS OF EVEREST

Some still wearing their electrically heated clothes, the pilots and observers are discussing incidents of the epoch-making flight over the world's loftiest mountain. From left to right: Colonel Etherton, Expedition secretary; Lord Clydesdale, Air Commodore Fellowes, Colonel Blacker (in plane), Flight Lieutenant McIntyre, and Photographer Bonnet. The equipment shown here includes oxygen flow-meters, manometers, regulators, heaters, altimeters, goggles, and rheostats.

among these were the Royal Aircraft Establishment and the R. A. F. School of Photography at South Farnborough, the R. A. F. Aircraft Depot at Karachi, and the Experimental Establishment at Martlesham.

The fitting out of the two Westland aircraft for their special work had involved much thought and planning.

The special planning came into the observers' department, and so it fell to me to work out the details in conjunction with Captain Keep, the talented designer of Westland Aircraft Works, to whom the Expedition owes a very great debt.

SPEED AND CLIMBING POWER WERE ESSENTIAL

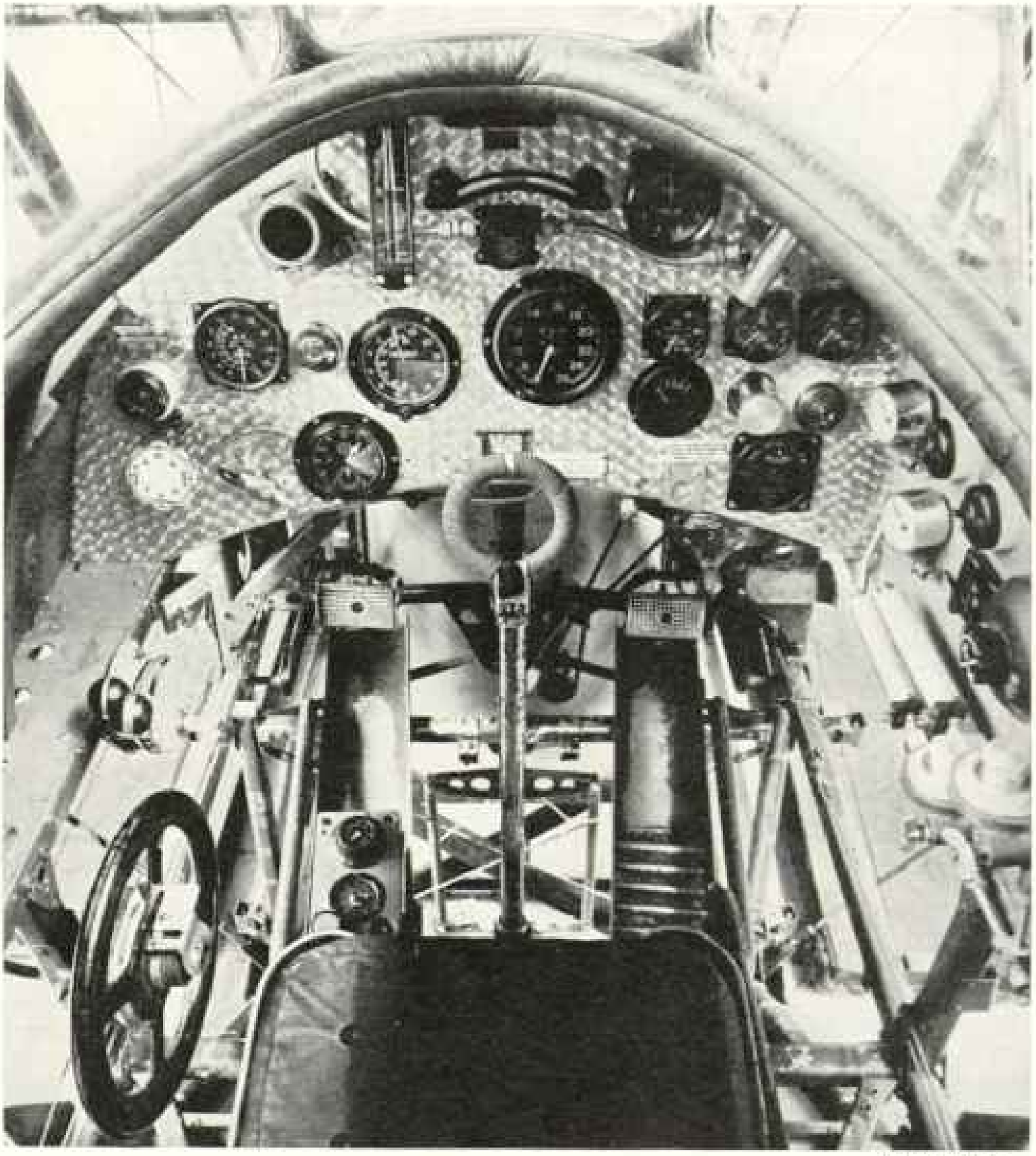
Apart from the oxygen installation, the pilots' cockpits differed little from the normal. The observer's compartment had to be redesigned. Both airplanes were two-seater "general purpose" military aircraft, originally armed with fixed Vickers guns for the pilot and carrying Lewis guns on rotating mountings for the air gunner.

The *P. V. 3*, which we renamed the *Houston-Westland* as a compliment to Lady Houston, had originally been planned to carry a torpedo as well as to have folding wings for ship stowage. All the armament was stripped off and replanning commenced.

We soon decided to inclose the rear cockpit, partly as an aid to keeping out the terrible cold of the upper air, but even more as an aid to "performance"—that is, to obtaining the utmost speed and climbing power.

The latter was clearly of the highest importance. The designer of the airplane would undertake that the machine would carry pilot, observer, four hours' fuel and oil, parachutes, two complete oxygen sets with an emergency reserve, and some eighty pounds in weight of camera equipment, to 33,000 feet. In addition, there was the all-important electrical installation.

At first sight, this height of 33,000 feet would seem to afford a fair margin of some 4,000 feet over the summit. Closer investigation by the scientists indicated, however,



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TO THE LAYMAN A PILOT'S COCKPIT IS A JIGSAW PUZZLE

On the left are the fuel air vent cock, the petrol feed tap, the engine switch, the clock, the air-speed indicator, the altimeter, and a spy hole to check the petrol flow—to mention only a few which are familiar to aviators. But many pilots who have not made altitude flights would be confused by some right-hand instruments, switches and taps, which include heating switches for clothes, gloves, boots, the camera flash bulb, and the oxygen-heating apparatus (see text, opposite page). The pilots of both Everest planes had to use virtually all these instruments on each flight.

that, in certain likely conditions of the atmosphere round about the mountain, it would be necessary to allow another 2,500 feet.

In other words, should the weather cause the air to be temporarily thin and tenuous, the machine might have that much more difficulty in climbing in comparison with its powers in what the meteorologists call a "standard atmosphere." This would reduce the margin to 1,350 feet—a bare 400 yards over that icy crest.

DOWN-DRAFT WINDS THREATEN CRASH ON CLIFFS

We knew that there would be a powerful down draft or overfall of wind, not only on the leeward side, but also, to a less extent,

on the windward side of the mountain. No one could forecast the strength of these, which might well be terrific; so that 1,350-foot margin was all there was to save the machine from being beaten down by the immense wind forces onto those terrific cliffs.

Therefore the extra 500 feet of ceiling which the inclosing of the cockpit offered us might make all the difference between success and disaster.

We constructed a roof with double flaps hinged along the sides of the fuselage, so that they could be folded down inward after the completion of the climb to allow the observer to put his head and shoulders outside. These flaps had transparent celastroid windows, and the arrangement worked excellently.

Next came the electrical installation. This was essential to the lives of pilot and observer, not merely in order to heat their clothing, but still more to supply current to the oxygen heaters. Unless the life-giving gas were heated, it might freeze solid in its tiny orifices of issue. In that event the pilot would lose consciousness in 35 seconds.

In a flight over level country he might possibly recover after the machine had swooped down out of control for ten or twenty thousand feet. Over the mountains there could be no such hope.

Thus the electrical supply was vital. Its planning was hedged round by special difficulties. A dynamo was necessary, and it is the usual practice to have this driven by a windmill. But a windmill would not act at the great heights unless specially designed, of enormous size and thus of corresponding weight and "drag." So it had to be driven by a gearing from the engine.

Fresh difficulties cropped up. No such large dynamo as we required had ever been installed; so special gears had to be designed and embodied. Next a battery was needed as a stand-by; but accumulators have the idiosyncrasy of giving no current in great cold. So the battery had to be packed about in felt and much trust placed in the interposition of Providence to save it from a chill. In actual reality, all depended upon the single dynamo, which rose nobly to the occasion.

The current had to go through two heated suits, two pairs of boots and gloves, and even through both pairs of goggles, which were warmed by tiny hot filaments cleverly inserted between two thin sheets of triplex glass.

Not less important was the warming of the many cameras which were to be carried and of their spare films. One of our difficulties was that celluloid film, when frozen, becomes brittle and flies to pieces if one attempts to bend it.

Of our eight cameras, three cine cameras and two survey cameras depended on this celluloid film. Here we met with difficulties that were almost heart-breaking. The films and the mechanisms proved temperamental to the last degree. Nor was it an easy matter on which to experiment. The airplanes had to be packed and shipped almost as soon as they were ready; so that tests in actual high flights could only be brief.

So we arranged with the leading British firm of refrigerating engineers, Messrs. Hall of Dartford, who most kindly fitted up a special chamber affording the extremely low temperatures down to minus 60 degrees centigrade—that is, 76 degrees below zero, Fahrenheit—which we needed. This was most costly to keep chilled for any long period; so tests, however vital, were necessarily hasty. At length we made everything work, but only just in time.

FORTIFYING CAMERAS AGAINST EXTREME COLD

Each of the eight cameras was provided with either internal heating elements or with a padded fabric jacket with heating wires sewn into it, similar to those in the suits (see illustration, page 142).

Not only did each camera, but the spare magazine for each survey camera and the spare spools for the cine cameras, call for heated jackets as well. Fortunately, the oblique cameras were a simpler problem, using plates; but it will be realized that each camera needed a flexible cable to be led to it, and the multiplicity of these in the cockpit formed a veritable spider's web.

To prevent the many leads getting tangled with oxygen pipes, connections for heated clothing, and with telephone leads was a formidable problem for the observer, hampered by the huge bulk of his suit.

At last all was reasonably ready on the very eve of the day on which the ship sailed; but, even so, many details remained to be completed in India. We carried out acceptance flights in which machines and engines performed admirably, giving more height than their designers had originally promised.

MAN'S FIRST NEAR VIEW OF EVEREST FROM THE AIR

Over the engines of the *Houston-Westland* on the first flight loomed this memorable spectacle. At this point first became evident the astounding rugged formation of the rock masses and the horizontal trail of the long snow plume, indication of a wind of blizzard force tearing across the summit and lifting clouds of powdered snow and ice particles. The bastionlike ridge in front of Everest is Chamlang and to the far right is the "armchair" crest of Makalu (see page 154).

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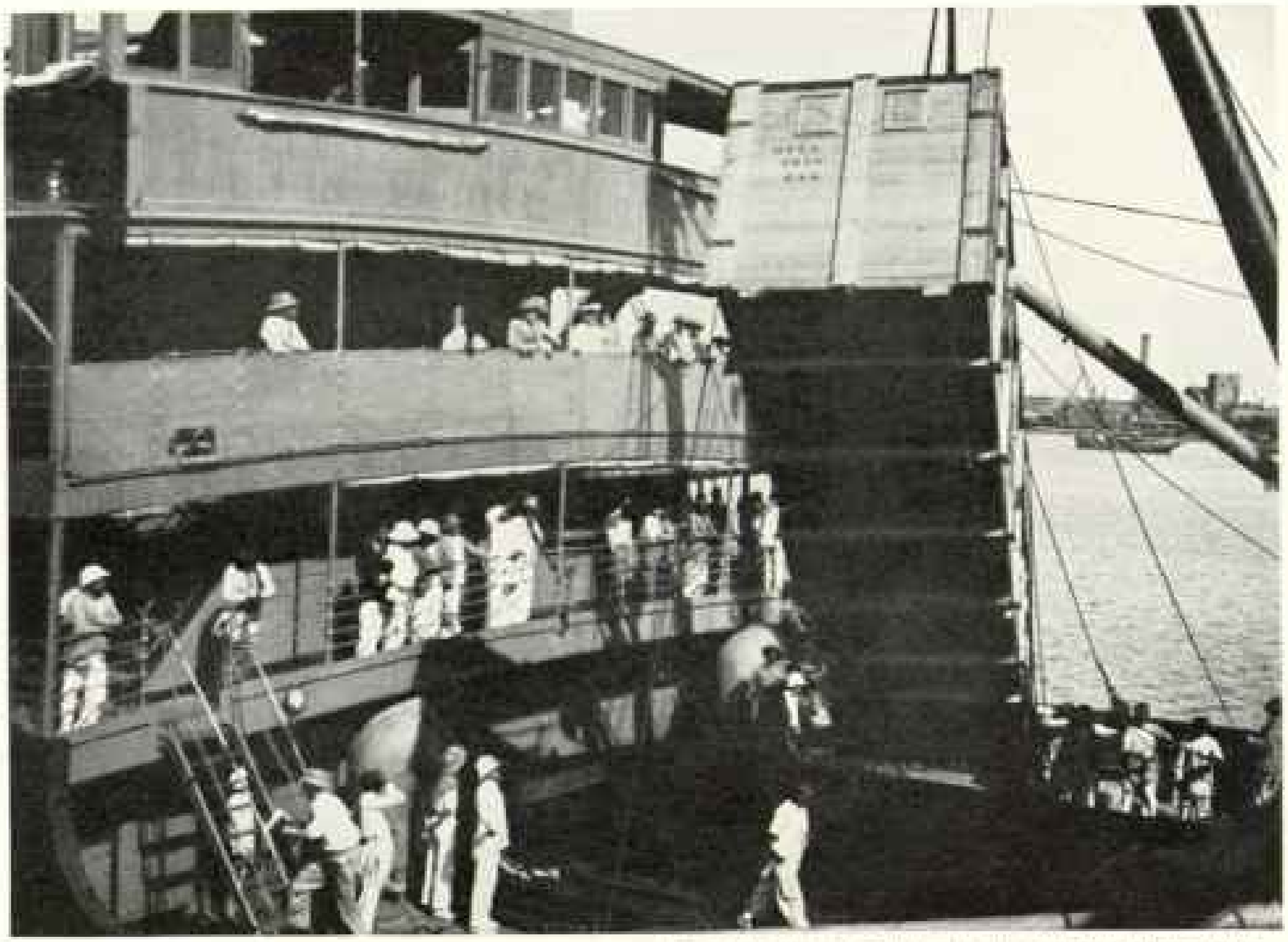
MEN MUST BREATHE, IN ALTITUDE FLYING AS IN DIVING

Difficulty of carrying enough oxygen was a major factor in defeating attempts to climb Everest. The function of the airplanes was the carrying of the air as well as the men, and also the cameras, which brought back panoramas and data no earth-bound explorers could have obtained. Here Air Commodore Fellowes is fitting Colonel Blacker with altitude equipment.

© London Times

PREPARING TO PEER INTO SECRET PLACES OF THE MOUNTAINS

A major scientific object of the Expedition was to photograph the conformation of inaccessible southern declivities of the massif out of reach of any climbing party. For this purpose oblique pictures were taken with hand cameras. The other objective was to take strip pictures with vertical cameras which would help map the lofty area (see illustration, page 142).



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UNLOADING THE CRATED PLANES AT KARACHI

After trial flights in England up to 35,000 feet altitude, the two airplanes were dismantled and shipped to the Indian port, where they were reassembled and flown to the Lalbalu flight base, near Purnea. Some of the Expedition members went to India by steamers, others by air.

They were rushed on board the *Dalgoma*, down whose hatches they had to be coaxed with much care and skill on the part of the stevedores.

Meanwhile we had enlisted the coöperation of the Gaumont-British Picture Corporation, in order to produce a cinema film of the highest order. They sent with us a brilliant director, Mr. Geoffrey Barkas, and cameramen of surpassing skill and experience, Messrs. Sidney Bonnet and A. L. Fisher.

We, the personnel of the Expedition, set out by divers means for Karachi, the progressive western air terminus of India.

Both pilots, Lord Clydesdale and Flight Lieut. D. F. McIntyre, flew out in Moth planes, accompanied by Air Commodore Fellowes, Mrs. Fellowes, Mr. E. C. Shepherd, of the London *Times*, who was specially attached to our Expedition, and Mr. C. H. Hughes, a competent ground engineer.

The three Moths arrived intact at Karachi, after a journey protracted by red tape and bad weather, in conditions which were considered by some judges to be more hazardous than the flight over the mountain itself. Colonel Etherton and the cinematograph party preferred the P. & O. mail steamer, which made better time, while I pinned my faith to the sturdy and reliable Hannibals of Imperial Airways.

My own means of transportation proved quickest, so I was able to go on ahead by train to Purnea to prepare the way. There I met with a most hospitable welcome from the small colony of planters.

MOGUL CITY BECOMES A NEWS CENTER

In former times the district had been a rich producer of indigo, but the industry declined, owing to the rise of aniline. Nor has jute replaced it except in a minor degree. In earlier days still, when Clive and Hastings thrust the Mogul viceroys from their jeweled thrones, it became an important garrison, watching the frontier of the militant and virile Kingdom of Nepal. The line of Mogul forts was bequeathed to the troops of the Honourable Company, and Purnea was

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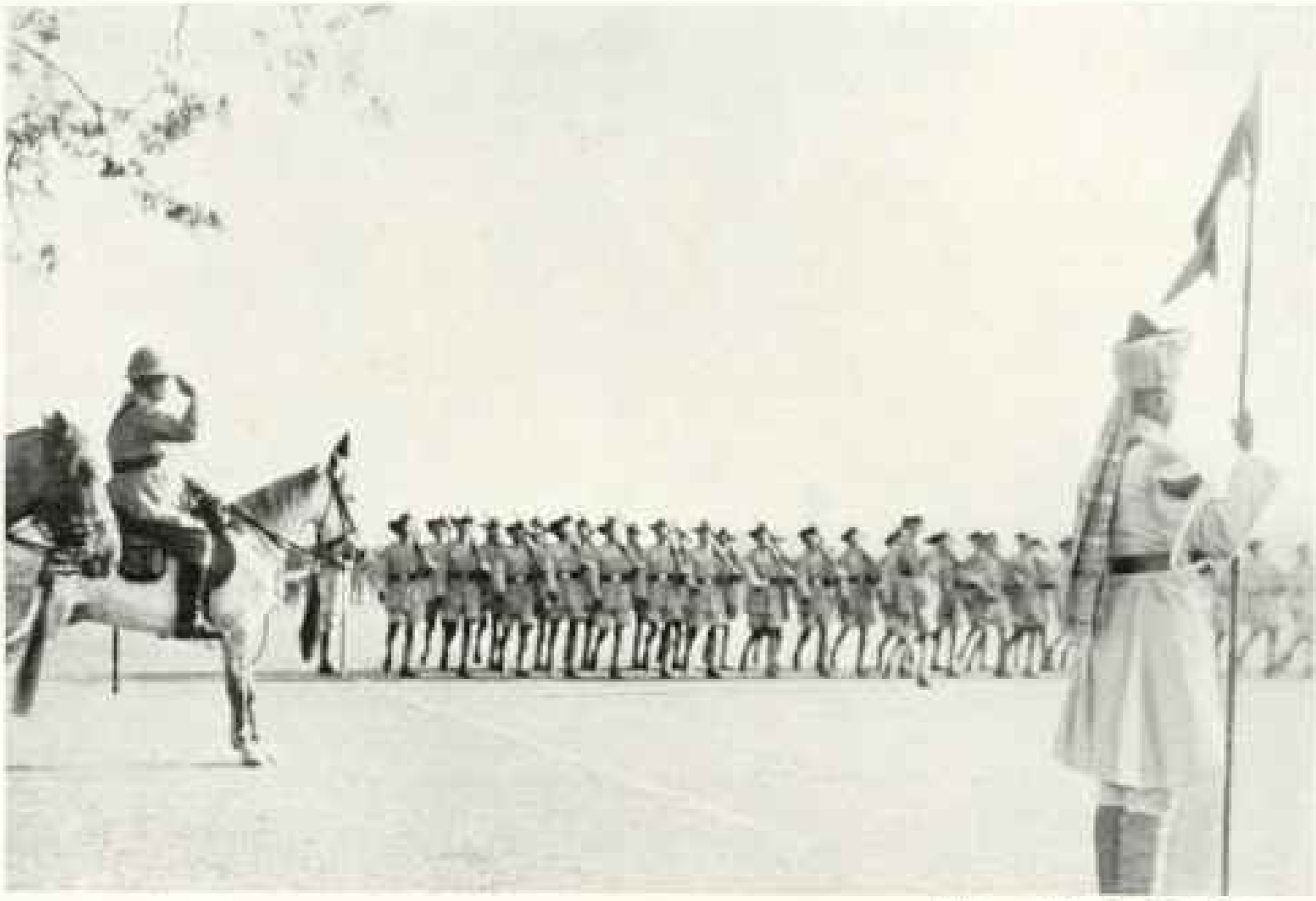
KINCHINJUNGA THRUSTS ITS HUGE BULK ABOVE THE CLOUDS

This massive mountain, which rivals Everest's height (see diagram, page 130), also has been the objective of many climbing expeditions. The photograph was taken more than a hundred miles distant by the use of the infra-red filter.



Photograph by Col. P. T. Etherton

THE MAHARAJA OF NEPAL RETURNS A SALUTE

The government of this mountain kingdom of nearly six million people is military. The hereditary Maharaja reigns, but the Prime Minister, who also is entitled Maharaja, rules and controls the army. Should you wish to address the sovereign, the correct form would be, His Majesty Mahârâjadhirâja Tribhubana Bir Bikram Jung Bahâdur Shah Bahâdur Shumshere Jung.

a whirl of feminine beauty and scarlet uniforms. Now three moldering cemeteries bear testimony in the form of baroque tombs to the brave days of old.

The thrill of the flight to Mount Everest brought Purnea into the limelight of the world's news. Excitement was intense, for few, even of the European inhabitants, had ever seen an airplane. I found preparations for our landing ground and canvas, steel-framed hangars well under way in the able hands of Mr. W. G. Came, executive engineer of Bhagalpur.

THE FIRST SIGHT OF THE MOUNTAIN!

Purnea is 60 miles south of the foothills of Nepal, in a flat, cultivated plain across which runs an amazing tract of level turf 30 miles long. We could have had landing grounds there for all the air forces of the world.

It was on our way there that we four, in the two Moths, received our first sight of the mountain. From Gaya we flew toward the great gray sand banks of the Ganges, athwart our course.

Beyond, suffused in a dense purple haze, lay the plains of Bihar, Asoka's ancient kingdom and the heart of his great empire.

Suddenly, up from the hard, straight line where the haze met the azure basin of the sky, appeared three wondrous points of white. Over our right wings we saw, wreathed in clouds, that which was Kinchinjunga, and ahead there enthralled our gaze the far-distant crests of Everest and Makalu (see diagram, page 130).

Three immaculate snowy pinnacles swam majestically alone over this wine-dark sea of mist. We could scarcely bear to glide down to land and so lose the beauty of this sight, even for an hour.

At Bhagalpur, the Boggley Wollah of Joseph Sedley and "Vanity Fair," we found not only efficient and energetic preparations in hand for our Expedition, but the most cordial hospitality from Mr. John R. Dain, the Commissioner, downward.

We flew on the 40 miles to Purnea, to find the landing ground already leveled and work well in hand on the hangars.

The hospitality of the people of Purnea

rivaled that of Bhagalpur, from Rajahs and broad-acred planters down to the humblest peasants, who made gay paper triumphal arches decorated with very creditable airplanes of tinsel.

So good were all arrangements being made on our behalf that we were soon able to fly back to Karachi in one of the Moths to bring up the big Westlands.

SUDDEN STORM WRECKS AN ANCHORED PLANE

Allahabad was our first night's stop. Here, to our misfortune, after we had lashed down our airplane for the night, a sudden great storm arose in a few minutes. Gusts of over 80 miles an hour tore down hundreds of trees, unroofed buildings, and plunged the whole city in darkness. We were then in the police chief's house, eight miles from the airdrome, arranging for a guard for the machine, when the sudden tempest came up out of a cloudless evening sky.

Hastening back in alarm, we found the machine uprooted from the huge blocks of concrete, the thick hemp mooring ropes snapped, and the graceful little airplane, which had been lifted bodily high into the air, a pathetic, crumpled wreck.

So we made our way sadly by train to Delhi, where a most generous Hindu gentleman, Mr. Chawla, who had earned fame by being the first Indian to fly himself out to India, very kindly lent us his own Puss Moth at a moment's notice.

This was characteristic of the warm-hearted attitude of the whole of India toward our Expedition.

Meanwhile Colonel Etherton had been invited by the Maharaja of Nepal to the beautiful and seldom-visited capital of Katmandu, to attend the coronation festivities there.

His Highness was kind enough now to renew to him his assurance that a second and necessary flight would be sanctioned, subject to certain conditions.

It had been recognized at an early stage in the organization of the Expedition that, in order to secure adequate scientific results, two flights would almost certainly be necessary.

Permission for the flight had been given by the Government "purely for scientific purposes," and it was hardly to be expected that all the mass of complicated and delicate mechanisms would operate without a hitch in those terrific extremes of heat and cold.

It was a relief to us to hear that we might expect to receive this essential permission. Without it there was a serious possibility of some minor hitch in the first flight which would compel us to return in ignominy without achieving our objects.

But before we heard this welcome news we were back in Karachi and found there the two Westlands assembled, all ready for their test flights. We took them up to more than 33,000 feet in that pellucid air and found all well. In fact, so efficient were Messrs. Siebe Gorman's electrically heated suits that the observer's knees became too hot. Without much difficulty we reduced the heating elements to moderation.

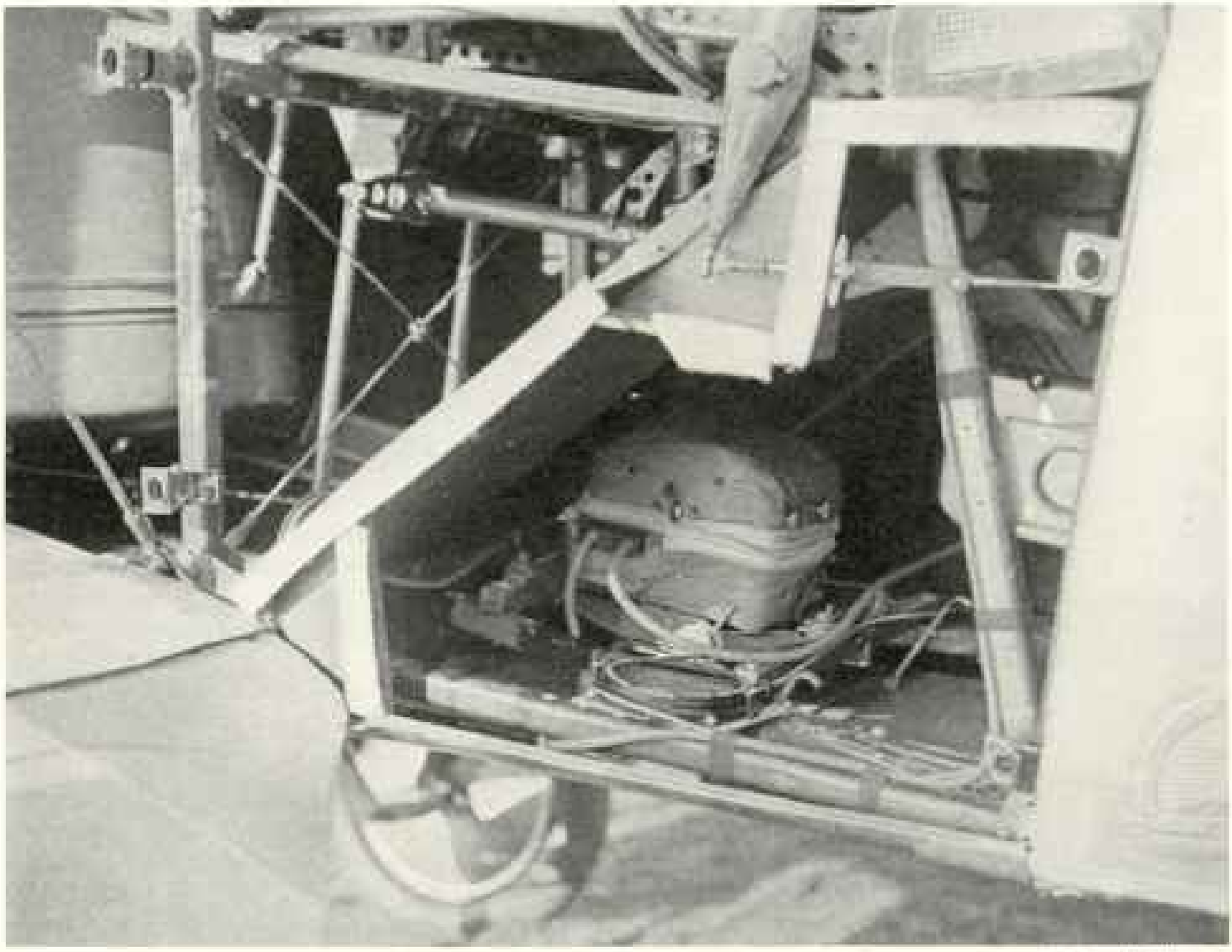
UNEXPECTED HEAT AT HIGH ALTITUDE

An interesting observation connected with this point was that the upper air at this altitude was 20 centigrade degrees warmer than in England in the month before. This was to some extent contrary to expectation, because we had been led to anticipate the same degree of cold almost everywhere at that great height. Hence, no doubt, the excess of warmth in the suits.

There followed the now accustomed hurly-burly of departure. A thousand items had to be packed and dispatched, some by train and some by air. Many, such as the oxygen and signal flares, demanded special transportation, while at the last moment it was discovered that the spare propellers would go into no ordinary railway wagon. Finally a horse box car was found to fill the bill.

Thus, on March 22, after a fortnight in Karachi, the Expedition bade farewell to the officers and men of that most efficient aircraft depot, who had assembled their machines, and flew, in the two Westlands and the two Moths, across the desert of Rajputana to Jodhpur.

His Highness the Maharaja of this Agency is air-minded in a very high degree. An excellent pilot himself, he flies almost daily, and has built an airport which would be a credit to almost any town in western Europe. There, in the feudal atmosphere, under the shadow of the massive stone castle, redolent of old-time Rajput chivalry, we slept in a luxurious modern airport guest-house with every comfort.



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THE SURVEY CAMERA HAD A THERMOSTAT

All cameras had to be electrically heated because, at extremely low temperatures, their movable parts contract and freeze tight, and photographic films become brittle. Also, the heater fitted into each film magazine had an electric device to prevent overheating at lower altitudes. Other cables ran to an ingenious electric control box which automatically determined the intervals of exposure, and warned the pilot by flashing a red lamp on his instrument board just before each exposure was made, so that he could keep his plane on an even keel.

Nothing could have surpassed His Highness's kindness and hospitality toward us and that of his nobles.

The next day we landed at the Civil Airport of Imperial Delhi to meet with another cordial welcome from everyone. In the afternoon we were honored by a special visit from His Excellency Lord Willingdon, the Viceroy of India, who inspected both Westlands and their complicated installations with great interest. We were his guests that night, and early next morning we flew once more to Purnea, where all was ready for the reception of the machines.

A MAHARAJA ENTERTAINS

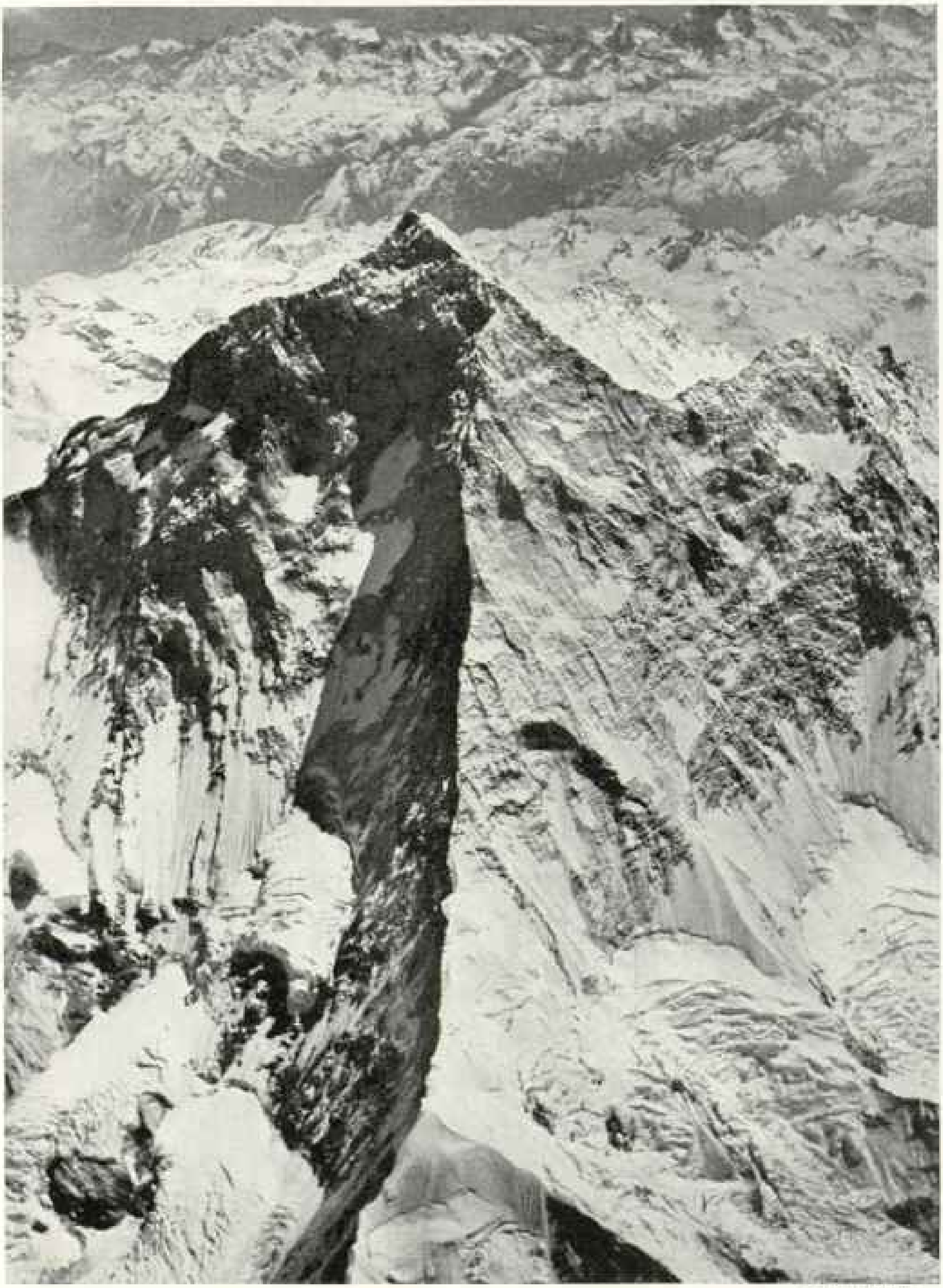
The Executive Engineer had made most admirable arrangements for landing grounds, hangars, water supply, and a dozen other matters, improvised from almost nothing.

The human portion of the Expedition became the guests of the Maharaja of Darbhanga in his most comfortable hundred-year-old house, which had been refurnished and fitted up specially for our reception.

It took us several days to settle in and unpack the multifarious stores, which came by rail several days after the airplanes.

Up till now the skies had been clear, there had been little ground haze, and almost no wind at low levels.

There seemed to be no reason for anxiety about the weather. I had written to Dr. Roy, Chief of the Meteorological Bureau, asking him to give the Expedition the assistance and advice of his department regarding the wind velocities at all heights up to 40,000 feet, together with the direction and the prospects of clear skies. He dispatched a party to Purnea, under the able charge of Mr. S. N. Gupta, who gave us



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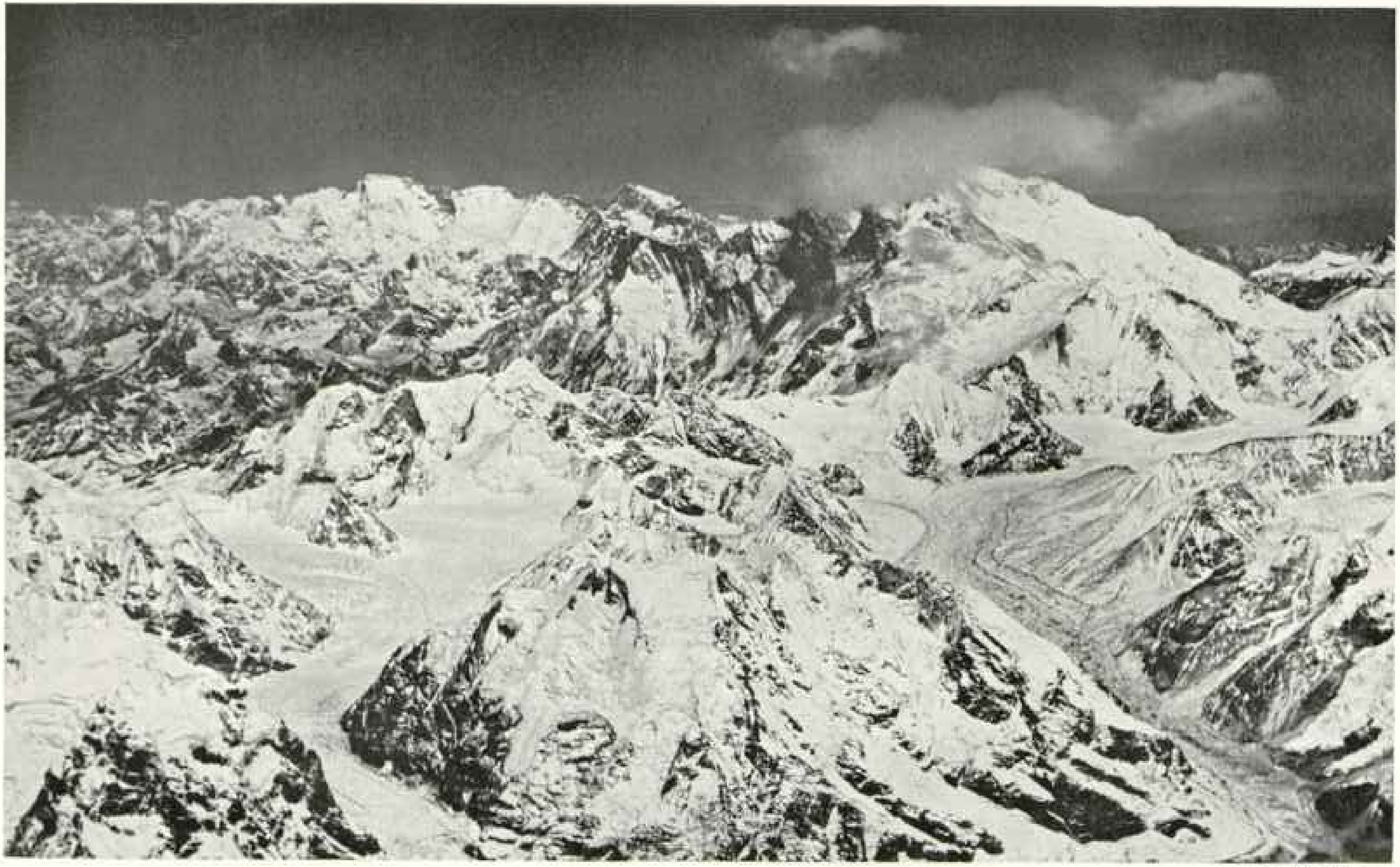
MAKALU AS IT APPEARS FROM EVEREST

This photograph reveals the western face of Everest's sister peak, with its sheer slopes, canyons, and ice masses. It was taken while the airplane was nearly over Mount Everest.



THE AWE-INSPIRING ARRAY OF PEAKS CULMINATING IN MOUNT EVEREST

Lhotse lies under the left edge of the cloud, and Chamlang is to the left center. The summit of Everest is obscured. Out of this maelstrom of mountains flows a huge ice river, with several of its tributaries. This photograph reveals hitherto-unknown aspects of the massive rock and ice formations of the southeast slopes of Everest.

Photograph from Wide World—© N. A. N. A.

ANCIENT TRANSPORT MINGLES WITH THE MODERN

Native Indian potentates came in state, mounted on lumbering, slate-gray elephants, panoplied with silks, silver, gold, and gems, to inspect the two trim planes. Rajahs, planters, and peasants extended every hospitality to the Expedition.

most valuable information and accurate forecasts.

Mr. Gupta sent up his sounding balloons even twice daily. This gave all information possible about the wind, which was supplemented from the observatory at Darjeeling, and then the two reports were collated at Calcutta.

UNSUSPECTED WIND VELOCITIES CAUSE ALARM

The results were most efficient and accurate, but began to cause us much alarm. No upper-air observations had previously been made in that area. The records of many years past gave velocities near the ground of a trifling order, very much within the capacity of our airplanes.

As the days went on and the machines were got ready, wind observations poured in steadily. Whenever the clearness of the sky allowed the theodolite observers to see the balloon up to 25,000 feet and above, the wind velocities became alarming, seldom under 70 miles an hour.

Previous official estimates tended to show that a 30-mile, or possibly a 40-mile, wind was the highest in which it was safe to make the attempt.

A strong wind from the west, its usual quarter, would tend to make the machines, traveling from south to north, drift sideways out of their course. The fact of having to steer somewhat into the wind to counteract this would be equivalent to flying a longer course, and hence result in burning more fuel. Thus, the stronger the wind "at height," the more fuel consumed.

So it became a question, if we were to make the attempt in a greater wind than that specified as permissible by the experts, whether there would be enough fuel for the return journey.

As a precaution, Air Commodore Fellowes already had an advanced landing ground prepared near Forbesganj, some 40 miles north of Purnea.

So we waited anxiously day by day for the 30,000-foot wind to drop to a reasonable figure.

Sometimes, when the wind speed seemed promising, the mountains would be covered by clouds—a circumstance naturally fatal to photography. We could not even afford to have the valleys on the southern slopes of the mountain cloud-filled, because this would cause a gap in the continuity of the all-important strip of air-survey photographs, which were the essence of the Expedition's work.

The weather at Purnea seems in April to go in 10- or 12-day cycles. It starts with a disturbance which might be a storm of rain. Then there are several clear days with little wind, characterized by cloud caps on the mountains.

As the cloud caps melt away and the peaks stand out clear, the wind speed seems to rise. Every morning one of our Moths went up, piloted usually by Air Commodore Fellowes, to a few thousand feet. At this height the three great mountains were always clearly visible, and it could be seen to what extent they were free from clouds.

We waited eagerly and anxiously for the evening telegram from Calcutta, with its weather forecast, and then for the early morning reports from the Moth pilot and from the balloon observers. Should we ever get a moderate wind without a mass of cloud? All seemed to depend on this. The weather factor had become a much greater one than we had foreseen.

Anxiously we all discussed the matter, always with the able advice of the meteorologists.

A SUNDAY OF ANXIETY

The Friday came of that memorable week; then the Saturday. The wind reports showed high, but diminishing velocities. On Sunday the speeds had lessened. We could scarcely sleep for anxiety.

The evening telegram foretold a still further drop. Would it be borne out in the morning? Would the clouds have gathered, or would the pendulum swing again back to greater winds? We decided that we must take the risk of flying in a much higher wind and watching the fuel consumption very carefully.

Then came Monday, an auspicious day, so said the astrologers. The Moth reported the mountain crystal clear, the meteorologists gave a wind of 57 miles an hour at the height. The die was cast; we drove breathlessly the nine miles to the landing field, at Lalbahu, and fretted and fumed at the manifold careful last-minute preparations which had to be made by our splendid skilled aircraftsmen.

The four of us lowered ourselves clumsily, sweltering already in the heavy suits, into

Photograph by Col. P. T. Etherton

MUCH OF NEPAL'S FREIGHT IS CARRIED ON HUMAN BACKS

Women as well as men bear surprisingly heavy loads, usually suspended from a strap across the forehead. A story is current that one woman carried a piano for more than a hundred miles. The youngster in the foreground is camera shy, not a victim of mountain headache.

the two machines. Lord Clydesdale, chief pilot, and I, as observer and photographer, flew in the *Houston-Westland;* Flight Lieutenant McIntyre and Bonnet flew in the *Westland-Wallace.* It was 8:25 in the morning of April 3, 1933.

ALOFT AT LAST!

Suddenly the familiar bumping trundle died away into smooth flight, as our clumsy earth-bound planes became graceful, airborne creatures.

The spirit of the machine was transmuted, and with it the spirit of the men.

The thousand anxieties of airdrome preparations faded into a forgotten past. I found myself as one in an ecstasy. Thus do infantrymen feel when their leader's hand signals them over their parapet into a blast of fire.

A moment before I was assailed by a hundred trepidations about each of a hundred mechanisms.

Now all was wiped clear. The inner consciousness mesmerized me to believe that nothing could go wrong. Many honest men had toiled to make that great honest engine before us. It was incapable of treachery. I looked at the struts and wings. They were honest, too. No maelstrom of winds could break that faithful work, which drove cleanly upward to the huge thrust of the engine.

Perhaps a few minutes passed as I was in this reverie. Then, as the faintly checkered plow lands melted into a purple monochrome, I wrenched my mind back to the real things of the world.

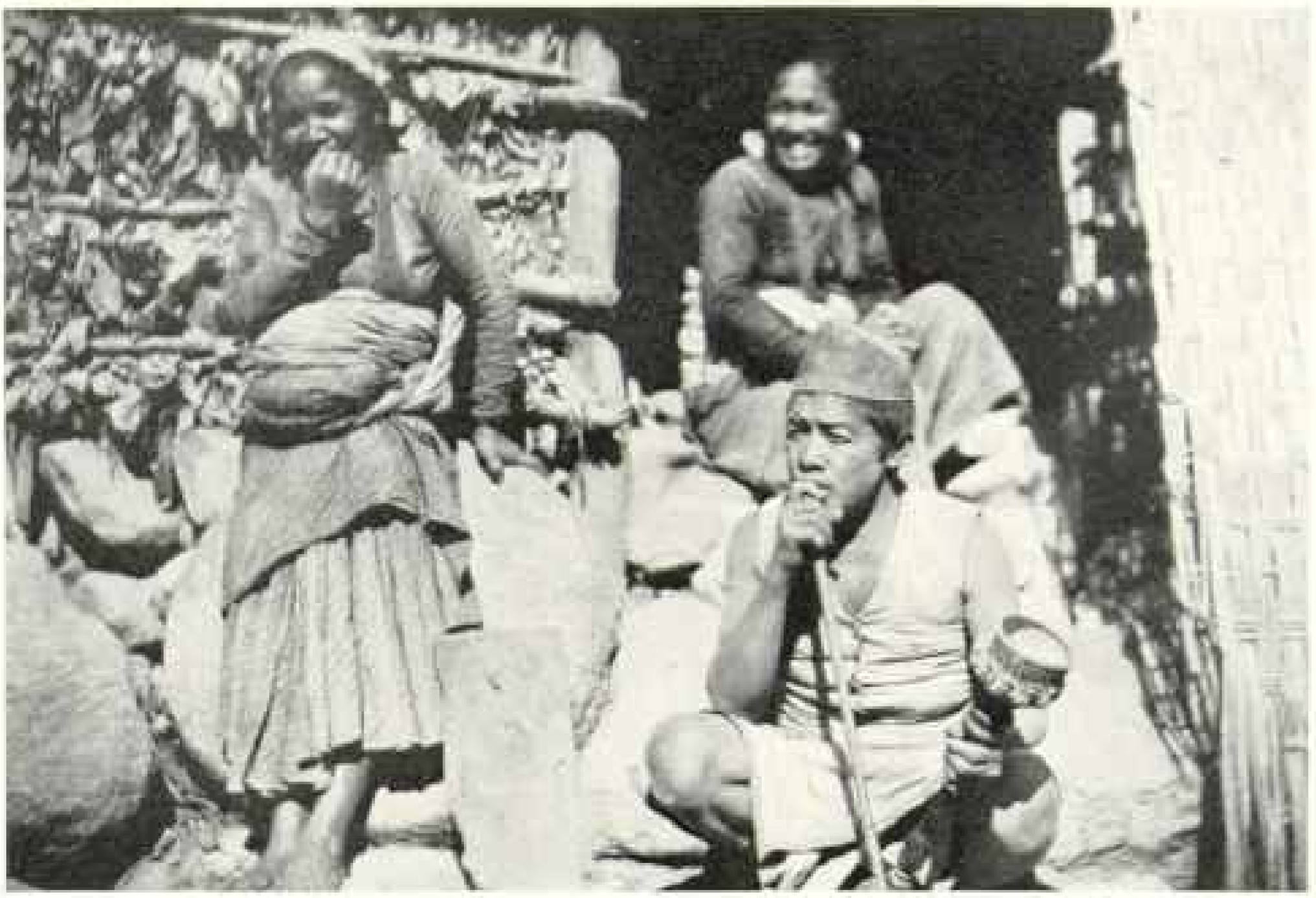
Was the dynamo "building-up?" I snapped over the main switch and slid up the rheostat. The needle remained still. There was no time to be lost. I snatched off my gloves and forced a thumbnail into the screw slots of the cut-out cover. A moment of doubt and then it came loose.

I pressed the contacts together, and to my joy the voltmeter needle swung slowly across the scale. Then, snapping switches, I tested everything. A little glow of heat showed that suits, gloves, and cameras were warm. Then, putting my hand to my mask, I pressed the little microphone lever.

Crackles and buzzings followed, nor by any manner of means could I put it to

BUILDINGS ARE ORNATE IN SEQUESTERED KATMANDU

The main squares in the Nepalese capital, such as the one into which this street leads, are filled with a bewildering array of palaces, temples, and houses, fancifully decorated with wood carvings and multiple roofs. Colonel Etherton, secretary of the Expedition, journeyed there at the invitation of the Maharaja to attend coronation festivities, and while there received sanction for a second flight over the forbidden kingdom (see text, page 141).



Photographs by Col. P. T. Etherton

A FAMILY OF THE NEPAL COUNTRYSIDE

They toil hard, raising scanty crops in the hills, or tending cattle, but they are cheery and hospitable to the few strangers who visit their isolated kingdom.

© London Times.

CRUISING OVER THE ROOF OF THE WORLD

Both the Expedition planes, flying at about 32,000 feet, are approaching Mount Everest, and the one in the picture is nearly over the cliffs of Lhotse. Near this point the planes experienced the tremendous down draft, which caused a loss in altitude of about 2,000 feet in a few seconds (see text, page 151).

rights. The pilot protested vigorously against the uncouth noises in his ears, and finally I was forced to disconnect everything. This was a misfortune and contributed to another with the photography.

Now I had leisure to look about me and see our strong-winged progress to the low, black-treed Mahabharat Range athwart our course, which flanked the frontier of Nepal, blurred over in the thick haze of the dust of the plains.

A little to the left I could see a winding gray skein of streaks where the Kosi burst out from the gorges.

In front the thick ground haze rose up to a hard, unbroken level line where it met the sky, as hard as the line of the wing against it.

AN AIR PANORAMA OF THE WORLD'S HIGHEST MOUNTAINS

Behind was our supporting airplane, clean and seemingly motionless, against the deep blue.

So we went for many minutes till suddenly, 80 miles to the east, a tiny, immaculate, snowy crest rose above the purple sea.

Here was Kinchinjunga, her cloud veil flowing from her crest, purest white against purest blue (see page 139).

A moment later came Everest herself, flanked by the snowy pyramid of Makalu.

ROADS INTO NEPAL ARE PURPOSELY KEPT IN POOR REPAIR

Nepalese prefer to discourage visitors and live a life apart. There are a few excellent highways and a 25-mile spur of railway extends into the southern edge of Nepal from India. A telephone line now reaches the capital. The Expedition, because of its scientific aims, obtained special permission to fly over this kingdom (see text, page 179).

Photographs by Col. P. T. Etherton

SALUTE!

The Gurkhas of Nepal are one of the most martial peoples in the world. Their major occupation is military service, both in their own country and in the States of India.

Slowly they grew up above the straight line of the haze, while I worked hard with slide, shutter, and exposure lever to record their beauties (page 131).

More and more peaks came into view, until soon serried ranks stretched as far as the eye could reach to the westward, and to Kinchinjunga to the east and north, broken only by the gap of the Arun Gorge, where the mighty river comes down from the high plains of Tibet.

Soon far to the northward, it may have been hundreds of miles away, there peeped up more white peaks over the very shoulder of Everest.

By some trick of vision, these seemed even higher than the great mountain itself. I had not much time left for wondering. Now I had to see that the voltmeter was registering enough and to adjust the rheostat, as the pilot and myself switched on the current into our suits

Nor might I let it go up too high, since there was danger of a fuse blowing, which would allow everything to chill and freeze, swamped by the quick, overwhelming cold of the vast space beyond the earth.

I glanced down at the big, vertical camera and saw its hand knob turn. This indicated that for the moment it was working well.

Now we were flying above and along the crest of the Chamlang Ridge, which runs almost up to the mountain from the south. It culminates in a peak of some 24,000 feet and is separated from the Everest mass itself by depressions filled with glaciers and snow beds.

Photograph from Wide World—© N. A. N. A.

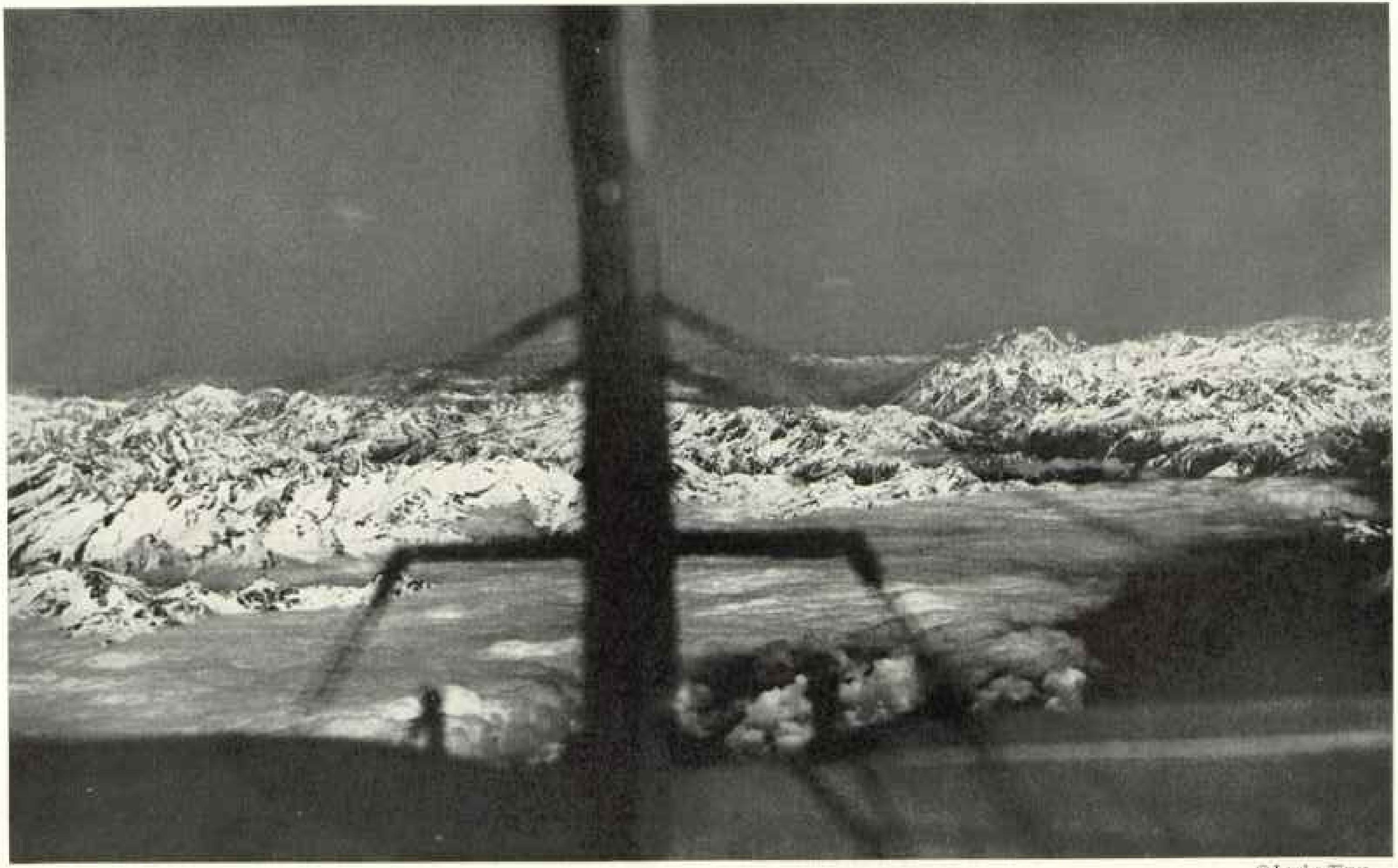
THE EVEREST MAIL GOES ABOARD

Colonel Etherton is handing over a package of letters to be carried in the *Westland-Wallace* on its trip to Mount Everest's summit. The letters bore a special canceling stamp and were afterwards forwarded by air mail to Europe. They included letters to His Majesty the King, the Prince of Wales, and Lady Houston, sponsor of the Expedition.

Now, the altimeter showing above 32,000 feet, we came over the end of Chamlang and saw towering before us Lhotse and the very mountain of inviolate Everest (see page 149). Suddenly, as I was occupied with recharging my cameras, I felt the airplane sink rapidly beneath my feet. A glance at the altimeter showed that we had lost a good many hundred feet in a few seconds.

A SIGHT NO MAN HAD SEEN BEFORE

I stood up and looked out to see Everest itself, so immense in front of us that it seemed that we could scarcely clear the summit. But up and up our great engine



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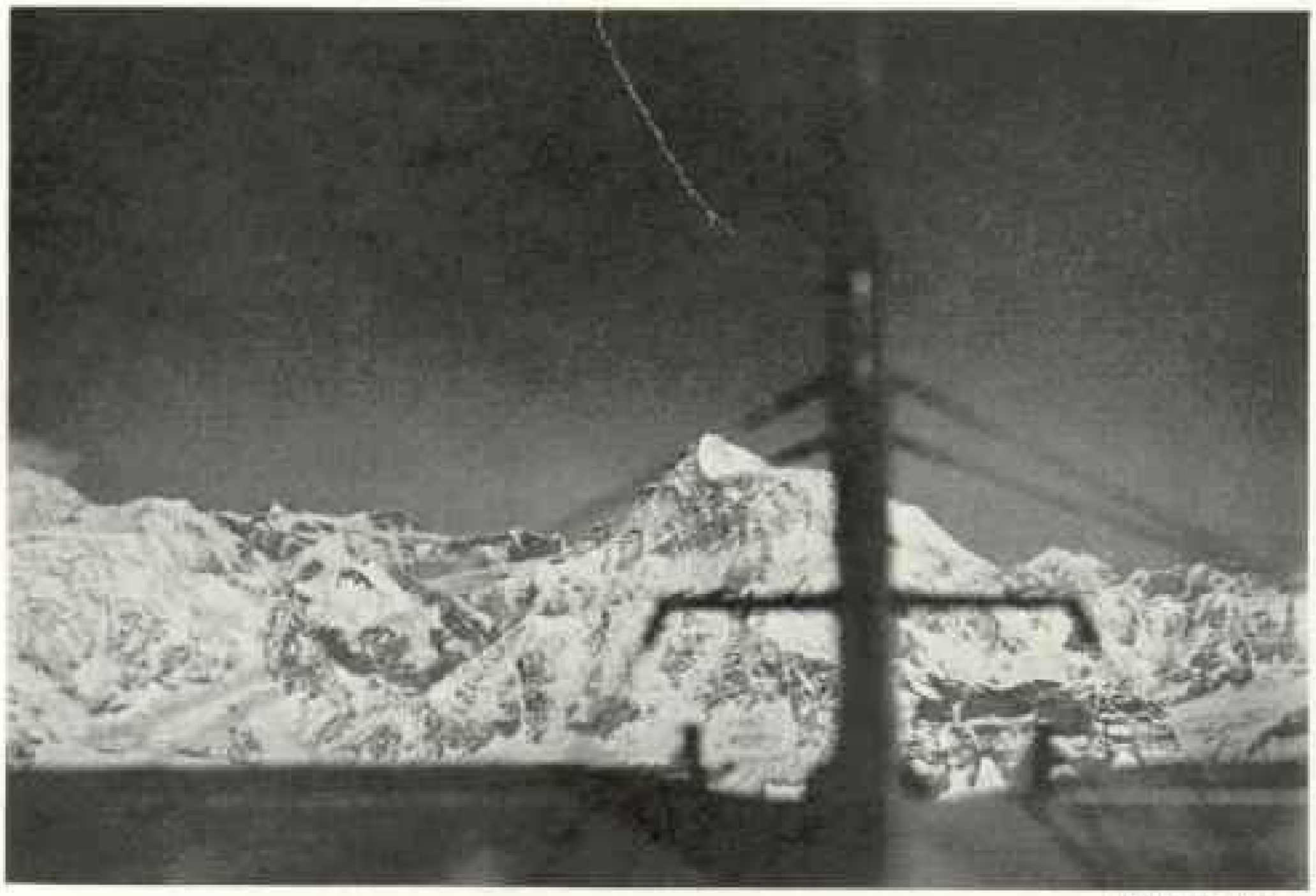
OVER THE TAIL: THE GREAT GORGES OF THE ARUN CUT LIKE A FURROW THROUGH THE HIMALAYAS

The gorges with countless cliffs of black rock and terrific ice slopes lie to the right of the rudder. No Cæsar of India ever could cross these super-Alps into Central Asia. But they act as one of Nature's mightiest irrigation reservoirs, storing incredible masses of ice and snow that ultimately become the streams that provide the water and carry the silt which give life to millions of people in India's northern plains.

Photograph from Wide World—© N. A. N. A.

AN AIR VIEW OF DARJEELING, BASE OF MANY CLIMBING EXPEDITIONS

The lofty Indian city is perched upon a veritable grand canyon in the foothills of the Himalayas. To thousands of visitors it is primarily an observation post of the Himalayas; for, from its vicinity, on clear days, views of both Everest and Kinchinjunga may be obtained. Weather observations made here were collated with those of other places for the Everest flyers (see text, page 142). This photograph was made from an elevation of 13,800 feet.



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MAKALU HAS BEEN CALLED MOTHER NATURE'S GREAT ARMCHAIR

The mighty companion of Everest is upholstered in a snow and ice cushion of astounding whiteness. This view reveals the southeast face, and shows how it is buttressed by imposing mountain masses.

© London Times—Courtesy Gaumont-British Picture Corp.

ROYAL ELEPHANTS HELP HONOR THE FLYERS

The Maharaja of Darbhanga, who owns these animals, was host to the Expedition members. He refurnished a comfortable home for their reception (see text, page 142).

THE BIRTH OF A LOFTY GLACIER

This amazing vertical photograph shows one of the huge glaciers under the mighty massif of Everest. It is one of a series of pictures from the survey strip, consisting of a series of overlapping vertical photographs, connecting the summit of Everest to a known point. Thus the mapping camera (see illustration, page 142) enables cartographers to fill in blank spaces on this hitherto-unexplored lofty area.

took us, and then the amazing, immaculate crest flashed past below us (page 158).

I looked down through the open floor and saw what no man since time began had ever seen before. No words can tell the awfulness of that vision. Entranced by both thought and sight, I was spellbound for a moment.

But immediately another great vortex or overfall of winds seized the machine, which swooped down 1,500 or perhaps 2,000 feet in a second or two.

The pilot turned her at once into the wind, her nose to the westward, and for some little space of time we battled against wind and downfall combined, so that for all our 120 miles of speed we scarcely made headway. But our splendid engine bore us up through and over everything and soon we were back over the vast, untrodden glacier south of the ranges.

As we came round over the topmost peak, we passed through the famous plume of the mountain, that awesome, miles-long white streamer which men see and marvel at 200 miles away. Huge flakes of ice rattled into

© London Times

A HOLY MAN TELLS HIS BEADS

He sits at the sacred ghats, or burning and bathing steps, near Katmandu, and is noted for his piety and self-denial. Hinduism of an early type is the religion of the Gurkhas and modifies the Buddhism of Nepal's primitive inhabitants.

the cockpit with such force as to break one of its windows.

The pilot, handling the machine with consummate skill, turned her in big curves, so that I could take a rapid succession of oblique pictures of those stupendous ice cliffs.

Then we came over the immaculate white pyramid of Makalu, joined to Everest by a grim knife edge. One or two more turns and the pilot was forced to turn back, since we dared not burn too much fuel.

A few more pictures and then that amazing peak came outlined sharply against our tall rudder (pp. 131, 136, 143, 154, 160).

Soon we were back over the gorges of the Arun, steering southward for our landing field (see page 152).

Our minds were still amazed by the vision we had looked on—that stark, savage beauty on which no man had ever set eyes before.

If life held no other achievement than this, still it were enough.

FROM THE HEIGHTS—TO A DISAPPOINTMENT

But when we landed, at 11:25 a. m., at Lalbalu, amid the congratulations of many spectators, our full joy was marred by a piece of sheer ill luck.

We discovered that matters had gone wrong with the vertical cameras! Dust haze had obscured the lower hills; so that, instead of complete and perfect overlapping strips, the results were scrappy and disjointed. The sum total would not have been worthy of the name of an air exploration.

Our disappointment was mitigated by the fact that no less than 35 oblique pictures turned out admirably, much surpassing expectations. One even showed the very crest itself a few hundred feet away, as we had swooped down over it.

Our real objective was not yet attained and our work for science was not completed.

More serious even was the fact that our pledges to the Government of the King of Nepal were unfulfilled.

From the beginning our Expedition had been a scientific one. We felt we had no right to ask a pilot to risk his life except for an honest scientific result.

In our case this object had been the exploration and mapping of the inaccessible

southern and western slopes and of the crest itself of the inviolate mountain.

The scientific world knew from the inception that we had planned to take these vertical strips and to attempt two flights in order to make sure of securing them.

We were now pressed to abandon our objective in a series of telegrams from England, for the most part from those who did not understand the Expedition or its motives.

To have done so would have been shameful beyond words, because there was no reason against a second flight except the personal risk.

FACING A SECOND START

So, after waiting for a spell of cloudy weather to pass away, the two planes started very early in the morning of April 19, once again for Everest.

There were all the anxieties to which we had grown almost accustomed, as to whether there might be a failure in some delicate but essential mechanism, but there was a fresh one in addition.

The wind strength at 24,000 feet was observed, from the theodolite readings, to be 88 miles an hour and stronger at the greater heights.

So we were forced to use a navigational device which Flight Lieutenant McIntyre had ingeniously worked out for just such a contingency.

We flew a little north of west until we had made nearly a hundred miles of westing inside British territory, and at a height of only 3,000 feet, where the wind strength was trifling. Then we climbed to find the whole of central and southern Nepal smothered under a smooth blanket of cloud up to over 16,000 feet.

Now we had some very anxious moments. Everest and Makalu were gleaming brilliantly white to the north-northeast against the vault of blue. An ice streamer of immense length blew eastward from Everest's summit, bearing witness to the terrible force of the higher wind (see page 131).

The question was whether the southern and southwestern slopes, which we must explore, were clear of those fatal clouds. Until we were certain, we dared not turn

Photograph by Col. P. T. Etherton

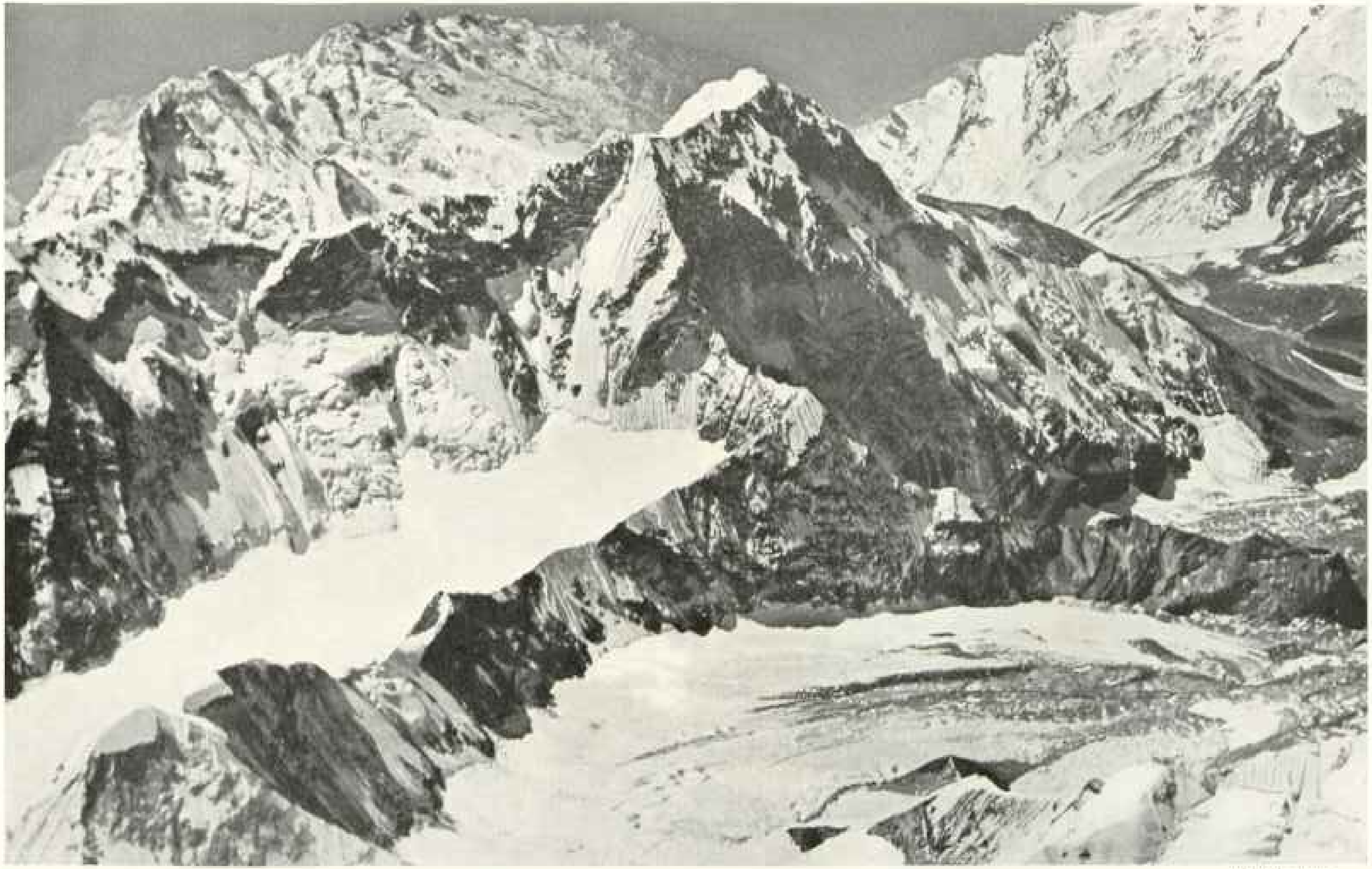
A LAMA AND HIS WIFE AT A MONASTERY IN KATMANDU

She is wearing a necklace of turquoises, which are found in the Himalayas. Well-to-do Nepalese women adorn themselves with lavish displays of shell ornaments, gold and silver nose and ear rings, and numerous trinkets.

© London Times

CIRCLING THE SUMMIT OF EVEREST—AND SOMETIMES ONLY 100 FEET OF CLEARANCE

This close-up of the dome of the world's roof is an epochal photograph in the annals of exploration, as were Peary's picture of the long-sought North Pole and Byrd's aërial panorama of the South Pole (see NATIONAL GEOGRAPHIC MAGAZINE, April, 1920, and August, 1930). A high wind is whipping the enormous snow plume eastward. In the center is the climbers' track, along which gallant Mallory and Irvine met death in the 1924 climbing expedition.



A MOUNTAIN WHICH AWAITS SURE IDENTIFICATION

Flying over territory which is unmapped, and never before observed from the air, the high-altitude photographs at varying angles raised problems which experts will require months to solve. This peak is probably the extreme west end of Chamlang, but it bears an amazing resemblance to Everest.

© London Times

MAKALU IS A MAJESTIC MOUNTAIN IN ITS OWN RIGHT

Flying west, with Chamlang astern, the Expedition obtained this photograph of the peak, which usually is considered a subsidiary of its neighbor, Everest. Under the left wing tip is Lhotse.

on our oxygen, because if we used it up we should no longer have a complete full set of the larger 750-liter cylinders, which would be indispensable for a third attempt.

So Lord Clydesdale held his hand, and we stuck it out till the needle showed 18,000 feet.

Fortunately, the telephone was working well, so we were able to talk to each other about the matter. The clouds opened out toward Everest and the die was cast. The pilot altered course to the northward, and in a moment we were flying again to the great mountain.

FLYING OVER A "QUILT OF CLOUDS"

For many miles there was nothing below us but the level white quilt of clouds. Then we crept slowly over a mountain valley full of terraced fields, cleft by a foaming river, nearly five miles straight below us. Fields and forested slopes soon gave way to snow fields, and snow fields to ice-bound gorges.

By now the electric drive of the survey camera had been switched on and the mechanism acted smoothly and well. However, I was determined to leave no loophole for mishap. Every twenty seconds the flexible leather-cased driving shaft between the motor and the camera would give a preliminary writhe.

Immediately, then, I grasped the hand-actuating mechanism and gave its aluminum knob a very gentle, persuasive turn. With a whir the film would change and the shutter be automatically reset for the next exposure. I had repeated this cycle carefully and anxiously several times when a new trouble showed itself.

As I looked vertically down through the open floor, I perceived that the wind force was now so great that our headway was practically nothing.

I telephoned to the pilot, who had already decided to put the machine on to a fresh course. Luckily we were far enough to the northward, so that our modified course would still take us over the Lhotse spur, which was really our objective, rather than the actual summit of Mount Everest.

A survey photograph taken over Lhotse would include the southern declivities of Everest, which was what we wanted. Our speed was now satisfactory, and the electric drive of the camera steadily did its work. I continued my intermittent coaxing to make sure. All seemed well, our supporting machine was close at hand, and

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WHAT ABOUT THE WEATHER TO-MORROW?

The success of the flight depended upon visibility and wind velocity. The latter, at high altitudes in the area to be flown, seldom was less than 70 miles an hour. Mr. S. N. Gupta (right center) made all-important observations twice daily at Purnea. These were supplemented by reports from Darjeeling, and the two were collated at Calcutta.

the mountain came ever closer and looked more tremendous.

The wind force, at 32,000 feet, was certainly about 110 miles an hour, but now ever so slightly in our favor.

In spite of its huge velocity, the wind stream was perfectly calm, and thus the level progress of our airplane boded well for the survey pictures.

Our previous experience had shown where we might expect the great horizontal eddy on the windward side of Lhotse, and our common sense led us to avoid entering it, as only harm would ensue from the tilt that must necessarily be imparted to the vertical photographs.

A BUSY TIME ALOFT

Meanwhile my own busy task kept me hard at work—indeed, panting for breath and racking my lungs to fill them with oxygen. Every few seconds I was forced to get down to the cockpit floor to supervise the fixed camera. In between, I had to spring up, reload the trusty Williamson P. 14, uncap the slide, set the shutter, select an object, steady the camera most solicitously against engine vibration, and release the lever.

Then, quickly, the slide had to be covered again and placed carefully in the cunningly devised slide box, with its spring lid. We had been forced to make these because of the amazing penetrative power which light seemed to possess at these altitudes.

In our early trial flights I had found it creeping in around the edges of dark slides and fogging the margins of the plates in the most exasperating manner.

The pilot flew the machine with that hardihood and surpassing accuracy which filled me now, as ever, with complete confidence.

Soon we flew once again over the terrible cliffs of Lhotse, scarred with its huge triangular crags. We came close once more to Everest, which had lost none of its majesty and entrancing beauty.

The machine circled serenely, as if the hurricane blast to which the six-mile-long plume from Everest summit bore witness, were a calm. I photographed incessantly, striving to remember the gaps of the first flight and to make them good for science.

© London Times—Courtesy Gaumont-British Picture Corp.

A REMNANT OF MOGUL SPLENDOR GREETS THE EXPEDITION

Elephants with brocaded fabrics, jeweled anklets, pulling a silver carriage studded with precious stones, appeared in a circuslike procession to honor the explorers. This is the equipage of the Maharaja of Darbhanga.

Now we were over the spurs and Everest, and now over the very peak of Makalu and the tangled ranges, yet untrodden, to the southeast.

THE GREATEST ANXIETY—AND TRIUMPH

Soon enough our time was finished. We could not linger; so regretfully we had to turn southward once again. Soon our rudder was silhouetted against the snowy pyramid of Makalu, the great gorges of the Arun opened out to the east of us, and we flew soberly to our landing field.

Now came our greatest anxiety.

We had risked all to make the survey photographs a success, and any one of a hundred mischances might have sent them awry. No cameras had ever before been asked to operate in those torrid heats and depths of cold, running unlubricated and never free from the impalpable, all-pervading dust of the plains.

I tore off my mask in the air, then my gloves and helmet, and unfastened the innumerable wires of my electric harness before the wheels touched the familiar green turf of Lalbalu. An anxious hour followed, as the skilled fingers of leading Aircraftsman D. H. Fraser worked in complete darkness.

We snatched at the great 40-foot film. All was well; our task was done. The Eagle cameras were victorious. Mount Everest had fallen to the assaults of science.

AFIELD WITH THE SPIDERS

Web Hunting in the Marshlands and Woodlands and Along the Lanes

By Henry E. Ewing

Entomologist, United States Department of Agriculture

FOR the spider enthusiast sojourning in the country, whether in the United States or in any other land of temperate climate, the dawn of a late midsummer day in a marsh meadow holds promise of delight. It is spider season, the time when the fairy spinners are to be observed at their best, when small, dainty webs, usually overlooked, stand out in perfect design against the green of leaf and grass, the filmy silk glistening with dew.

Webs, webs everywhere—hundreds of them, thousands of them—billow a gossamer sea in the morning light!

There are funnel webs, sheet webs, hammock webs, webs of indescribable shapes, and, finest of all, near the edge of the woods, the beautiful orb webs, bejeweled in their radiant symmetry.

Spiders are marvelous spinners. From the many microscopic spigots at the tips of their heavy abdomens they conjure several kinds of silk with which to construct webs of exquisite design and beauty. They make snares for their prey, sacs for their eggs, shelters for protection from enemies, draglines for security in movement, balloons for navigating the skies, and many other things for service in their varied and romantic lives.

FAMILY STYLES IN WEBS

Although the silken webs are of many different designs, the finery of the individual spider does not change with the passing seasons. Each species has its own style of web, to which all its members adhere so long as environment remains unaltered by geologic progress.

Students believe the first web, a simple tube, evolved from the draglines used by the spider in going in and out of a hole in the ground, its first retreat. These threads of silk finally lined the nest and radiated from the entrance. Striking against the lines, victims would be detected and seized by the watchful spider.

By extending the sheet about the entrance to the tube and bringing the latter out of the ground, the spider developed the funnel web. The axis of the web was shifted in the course of this change until the tube of the funnel became almost horizontal, and later the lower part was expanded into a net. These changes give us the typical funnel web, such as is spun by the common grass spider, *Agelena naevia* (see page 183).

Inside the tube of the funnel, especially when this tube leads backward among tangled blades of grasses, the spider still has protection from its enemies. The placing of the web above the ground and the expansion of the lower part of it into a sheet increased its efficiency as an insect snare.

INCREASING THE INSECT CATCH

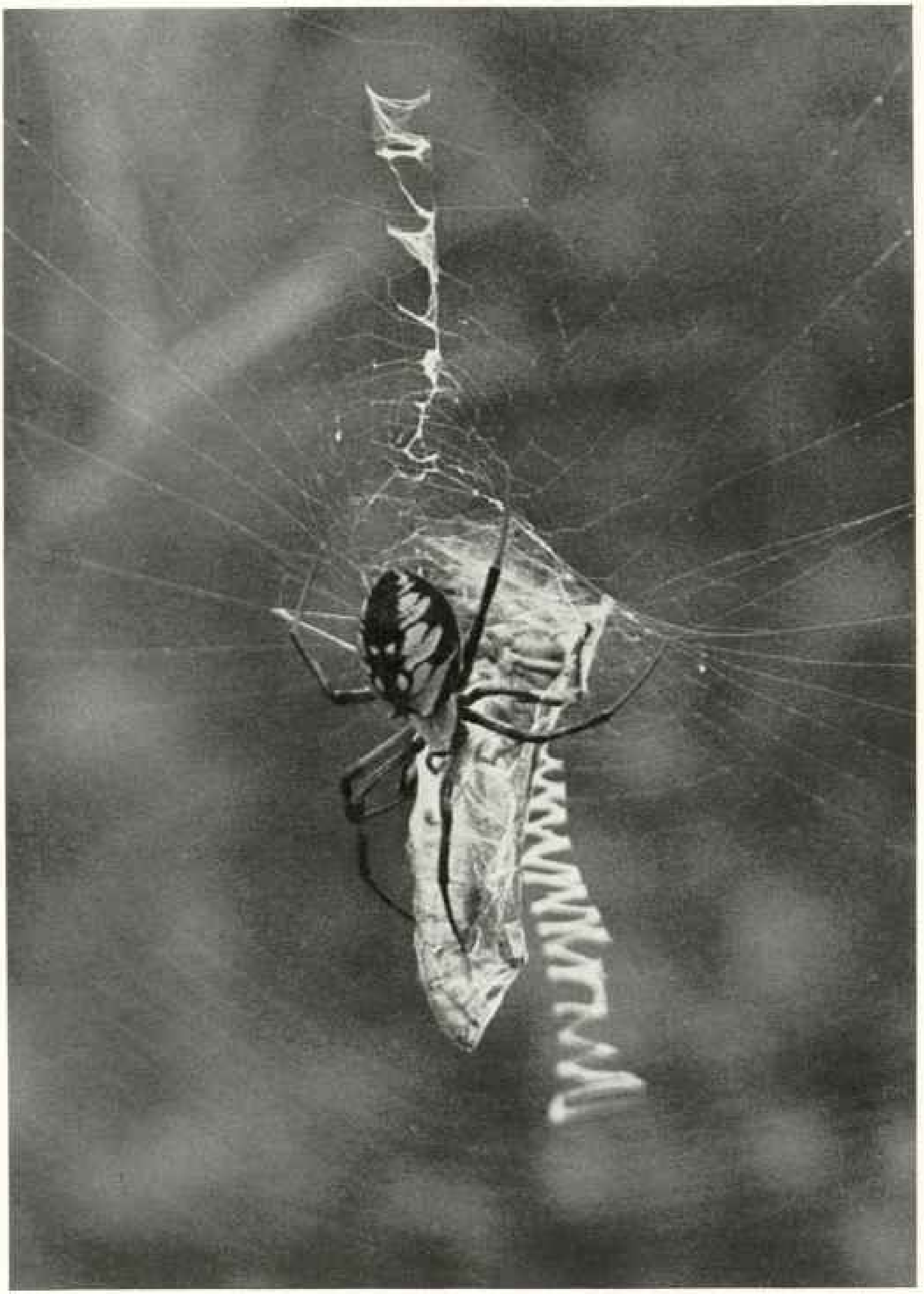
The tube, which leads away from the sheet part of a funnel web, becomes an inconvenience when webs are placed in exposed positions above the ground; hence the sheet-web weavers leave it out. By spinning the sheet in exposed positions, they are able to increase their catch of flying insects. Such closely woven sheets, however, offer dangerous resistance to the wind.

Spiders commonly modify sheet webs in two ways: They may bring the sides of the sheet upward to produce a hammock or bowl (see page 183), or downward to form a dome (see page 186).

The advantage of the bowl type is easily noted by observing our bowl and doily spider, *Linyphia communis*. It places its hammocklike web well below the tops of small shrubs or large herbaceous plants and directly under the favorite feeding places of such insects as plant lice and leaf-hoppers. Naturally every disturbance of the twigs and leaves shakes a shower of titbits into the snare.

The dome-shaped web is better suited for catching insects rising from the ground in flight, as many do about dusk or in the morning.

Irregular net webs, haphazard tangles of threads of all lengths, are spun by that annoyer of housewives in all temperate climates, the common house spider, *Theridion*



Photograph by Lynwood M. Chace

THE GOLDEN GARDEN SPIDER WEAVES A SHROUD

An unwary grasshopper has stepped into the perilous parlor of *Miranda aurantia* (see Color Plate V, lower left), and his hostess quickly spins a winding sheet about him. Although still alive, the victim cannot move a leg.

Photograph by Clifton Adams

HASHIME MURAYAMA PAINTS THE FRONTISPIECE FOR THE SPIDER COLOR SERIES

Working with an array of scientific instruments, a versatile artist of the National Geographic Magazine staff records in water colors the most minute details in the appearance of his subjects. He studied live specimens, kept in the jars at the right, and fed flies and other common insects.

tepidariorum (see Color Plate IV), and by many other species. Once considered primitive, such webs now are regarded as degenerate. They probably represent an evolution from the sheet type, altered to decrease resistance to the wind and to facilitate mending. As fly-traps, they are effective and, in addition, usually serve well for rearing the brood of spiderlings.

Like human fishermen, many spider species have found that a plane net of two dimensions is not only economical of weight and materials but ideal for landing a catch. The orb web, built on this principle, may be put in exposed places, where prey is most plentiful, since with its open construction it offers little resistance to the wind.

Suspended from a framework of stout base lines and carefully spaced to permit freedom of movement in spinning, its threads form a wheellike design of maximum strength with a minimum of material. The spider sits at the hub, ready instantly to detect a snared victim and pounce upon it. In the net-snare method of catching prey the orb web is the spider's last word. Few, if any, other animals, human or subhuman, have equaled it.

Although the most symmetrical web ever made by a spider is not really perfect, according to human standards, scientists marvel at the accuracy with which angles and distances are "measured."

SPIDER "GEOMETRY" IS INGENIOUS

The spider starts her geometrical web with perimeter lines connecting objects around a space large enough for her purpose. From these lines she suspends a few threads which converge at the center of the future web. Now begins the process of spacing the radii. She attaches the end of a new radius at the center and runs along a spoke already laid down, spinning out the silk for the new one as she goes. When she reaches the perimeter line, she takes a fixed number of steps along it and attaches the new thread. This process is repeated until all the desired radii are in place.

If the foundation lines should chance to form a wheel rim accurately circular, the distances between spokes would be equal;

but, since the perimeter is usually an irregular quadrangle and never a circle, the spacing varies somewhat.

The spiral turns of silk, which complete the net, are more accurately spaced than the radii, since the spinner lays down each new turn with her foreleg touching the last one. Thus the length of the forelegs and the size of the spider determine these distances.

"Scout stepping" and use of the "leg ruler" are instinctive in spiders. Even when isolated from its kind from the moment of its birth, a spiderling will produce exactly the same web design as its mother and in exactly the same manner.

Spiders constitute a large clan of some 25,000 described species. Although most abundant and diversified in the Tropics, they range far into the Arctic regions, and are found almost everywhere that earthly conditions will sustain life.

THE WORLD'S LOFTIEST DWELLERS

Far up on Mount Everest, above the highest plant life, at an elevation of 22,000 feet, spiders have been found living among the wind- and snow-swept rocks. Thus they are the loftiest permanent inhabitants of the earth.

Some spiders, such as the trapdoor makers, occupy only a restricted area; while others, such as our common house spider, *Theridion tepidariorum*, are found in many lands and all the continents.

The largest spiders are the American tarantulas, and of these the South American species, *Theraphosa leblondi*, with a body three and a half inches long, is the giant. Its bulk is more than 100,000 times that of the smallest spider known.

In Central America is found its closest rival in size, *Sericopelma communis* (see Color Plate II). South America produces both the Brobdingnagians and the Lilliputians of spiders, one of the latter, *Ogulnius obtectus*, being barely one-twenty-fifth of an inch in length.

Far from typifying masculine strength, aggressiveness, and dominance, the males of many spider species are much smaller than the females, and are such poor spinners that it is difficult for them to procure their own food. Some of them either use snares previously built by females or literally live on the "crumbs from the tables" of their mates. Males, however, are inclined to be more active than females and may be of roving disposition.

In a few species, such as the brush-legged spider (see Color Plate VI, B), the male, less than one-hundredth the size of the female, is little more than a fertilizing mechanism to insure the perpetuity of the species.

NEW CLOTHES FOR OLD

To allow for the expansion of the soft parts of the body during growth, spiders periodically cast their skins (see Color Plate II), new coats and new claws replacing the old. When tarantulas are exhibited singly, in cages, the sudden appearance of a cast skin, seemingly intact, may cause astonishment on the part of a keeper, who takes it to be another spider. The old skin splits along the sides of the body just above the bases of the legs. The suture passes from one side to the other in front, but does not pass around the rear of the body. In an insect, the old skin usually splits down the middle of the back.

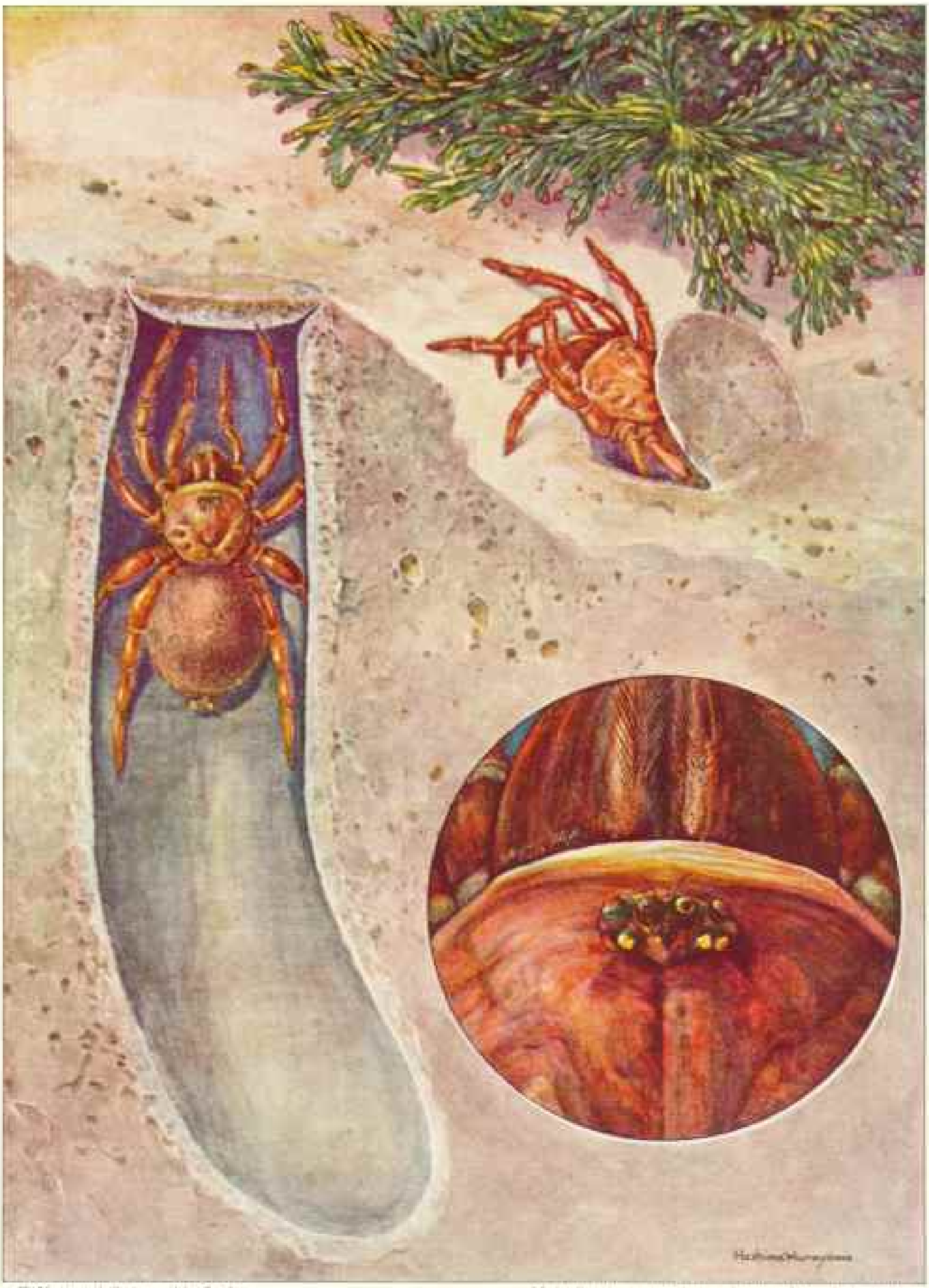
The spider does not, like the caterpillar, spin a cocoon about herself. How, then, does she place her egg mass in the silken sac? The problem puzzled me for years, until a common house spider solved it by a performance before my eyes.

First she spun a cone, or cap-shaped, base (see Color Plate IV). She did this by holding her weight with the first and second pairs of legs, rotating the structure with the third pair, and laying on the silk with the back pair.

After completing the base, she forced the egg mass out of the vulva (see Color Plate IV). The eggs, covered with a sticky substance, clung together in a ball, which she fixed in place by pushing it upward while she pulled the opposite margin of the silken base down and under it. This accomplished, she more leisurely completed the outline of the sac, thickened it by laying on much more silk, and finally finished it by tamping down the protruding loops with her mouth parts. The whole process of egg-laying and sac-making took about one hour.

SPIDER AVIATORS BUILD AIRSHIPS

Although wingless, spiders can take to the air and reach distant places. Nature has endowed them with the capacity of "balloon" building and given them such remarkable instincts for using these airships that few winged creatures can surpass their flying feats!



 Main figure natural size, inset enlarged six times

ONE KIND OF SPIDER LIVES IN HER OWN CELLAR

This trapdoor species, *Ptychylinnerus andonini*, common in South Atlantic States, closes her bottlelike basement home with a water-type lid, which she operates with her legs. Her California cousin, described in a separate article, makes a cork-type covering and opens it or holds it shut with her fangs and legs. The ocular turret of an eastern specimen is shown in the inset at the right.

Approximately one-half natural size

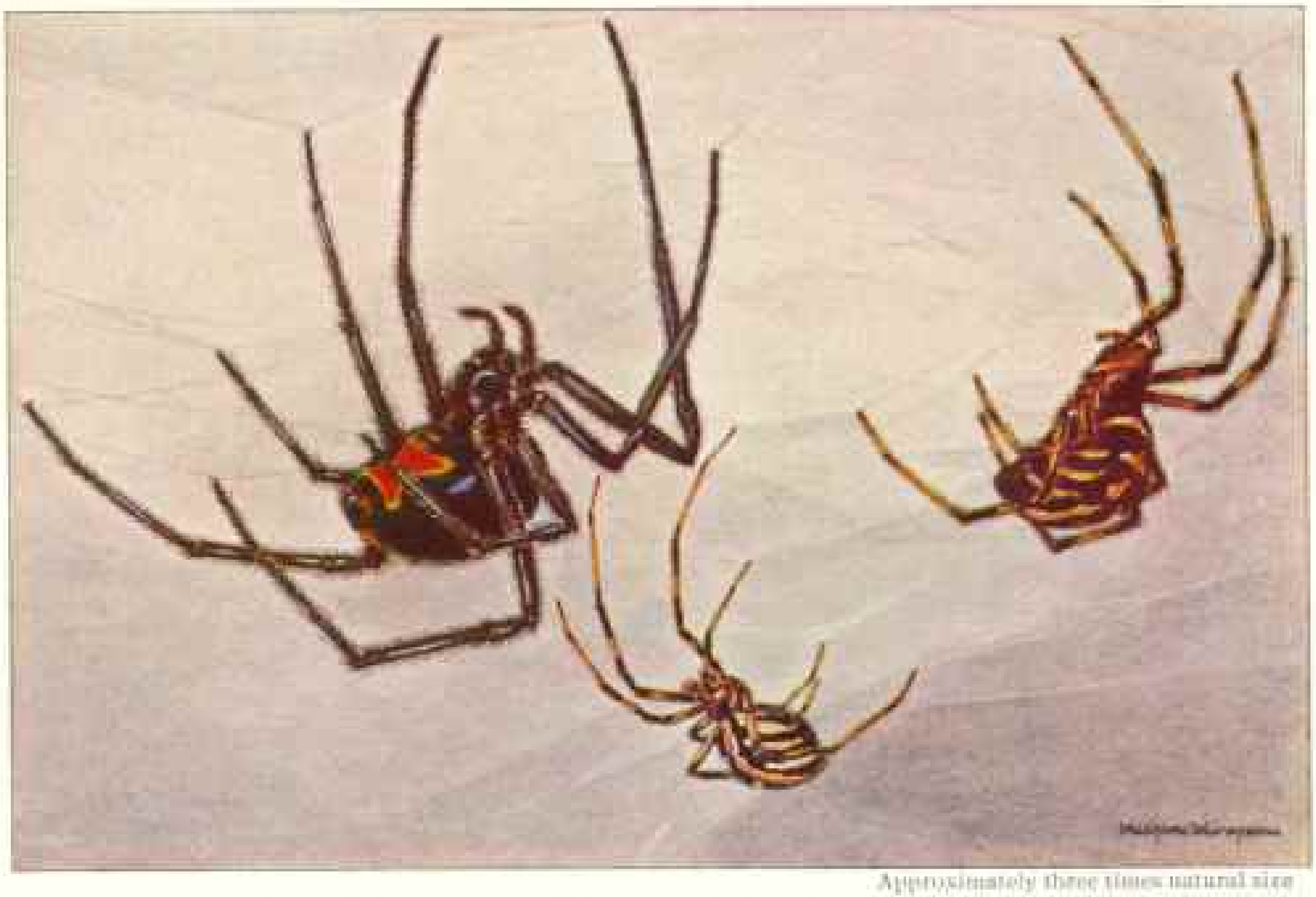
OUR COMMON WESTERN TARANTULA CRAWLS NEATLY OUT OF HIS SKIN

Though fearsome looking, with sharp fangs (lower inset) and large fuzzy body (upper inset), this adult male merits the friendship of his human neighbors in southwestern States, for he feeds on grasshoppers and roaches. The bite of the species is painful but not poisonous to man.

Approximately one-half natural size

MEMBERS OF ONLY ONE SPECIES EXCEED THIS GIANT IN SIZE

The Central American tarantula, *Sericopelma communis*, of which the specimen here shown is an adult male, catches and kills birds, but it is smaller than the *Theraphosa leblondi* of South America. Though extremely painful, its bite does not cause death.



Approximately three times natural size

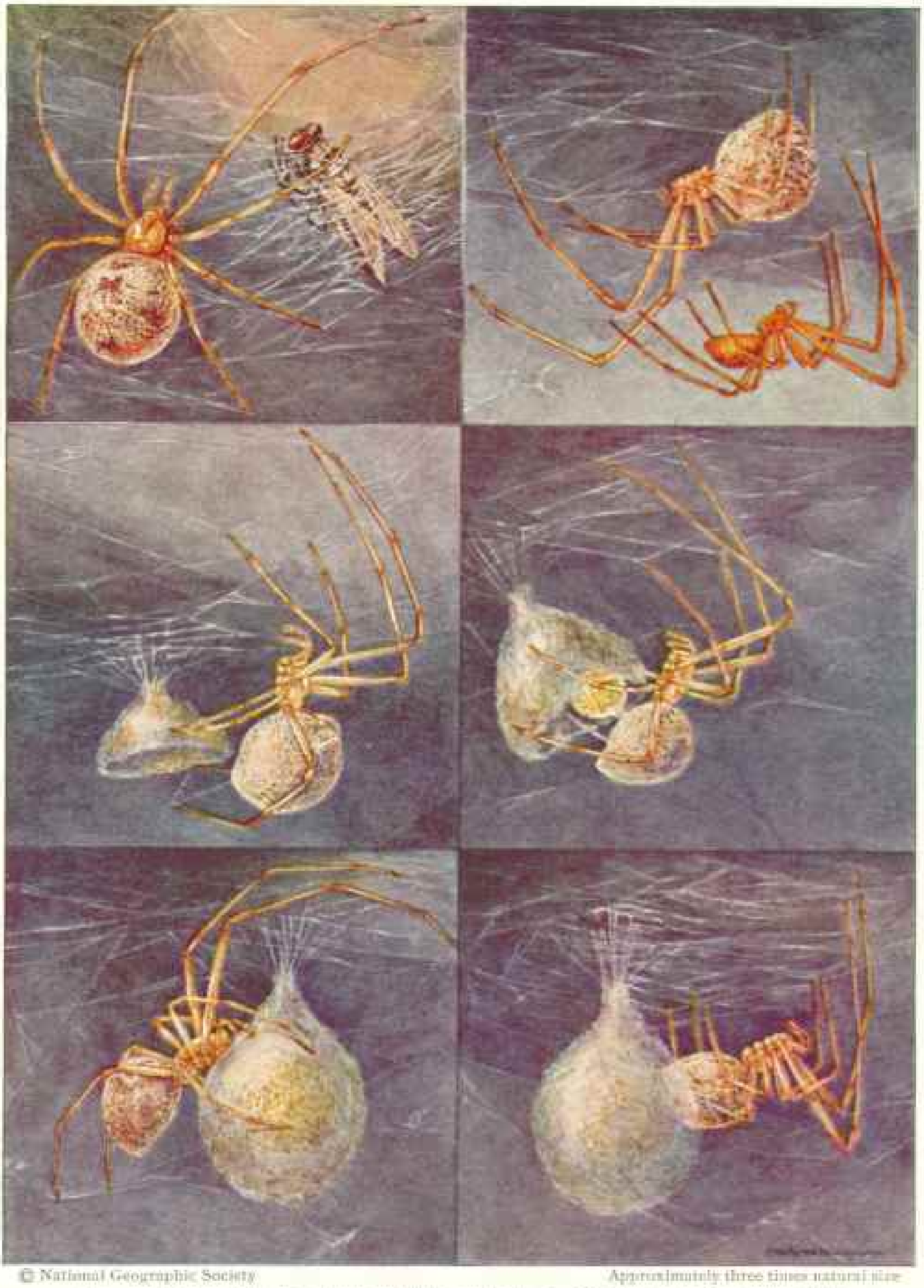
BEWARE THE BLACK WIDOW, MOST VENOMOUS SPIDER IN THE UNITED STATES

Beautiful but dangerous, *Latrodectus mactans* should be shunned. The adult female (left) measures almost a half inch in length, twice as large as her mate (below). The daughter (right) until mature resembles the father. Rather common in the South, the species is rare in the North.

Approximately one and one-half times natural size

NOT DADDY LONGLEGS, BUT SPIDERS

Around back doors or in basements in the warmer countries, pairs of *Pholcus phalangioides* build their irregular webs. The female (right) carries her egg mass in her jaws and feeds little till the young are hatched. The mate, unlike males of other species, can take care of himself.



 Approximately three times natural size

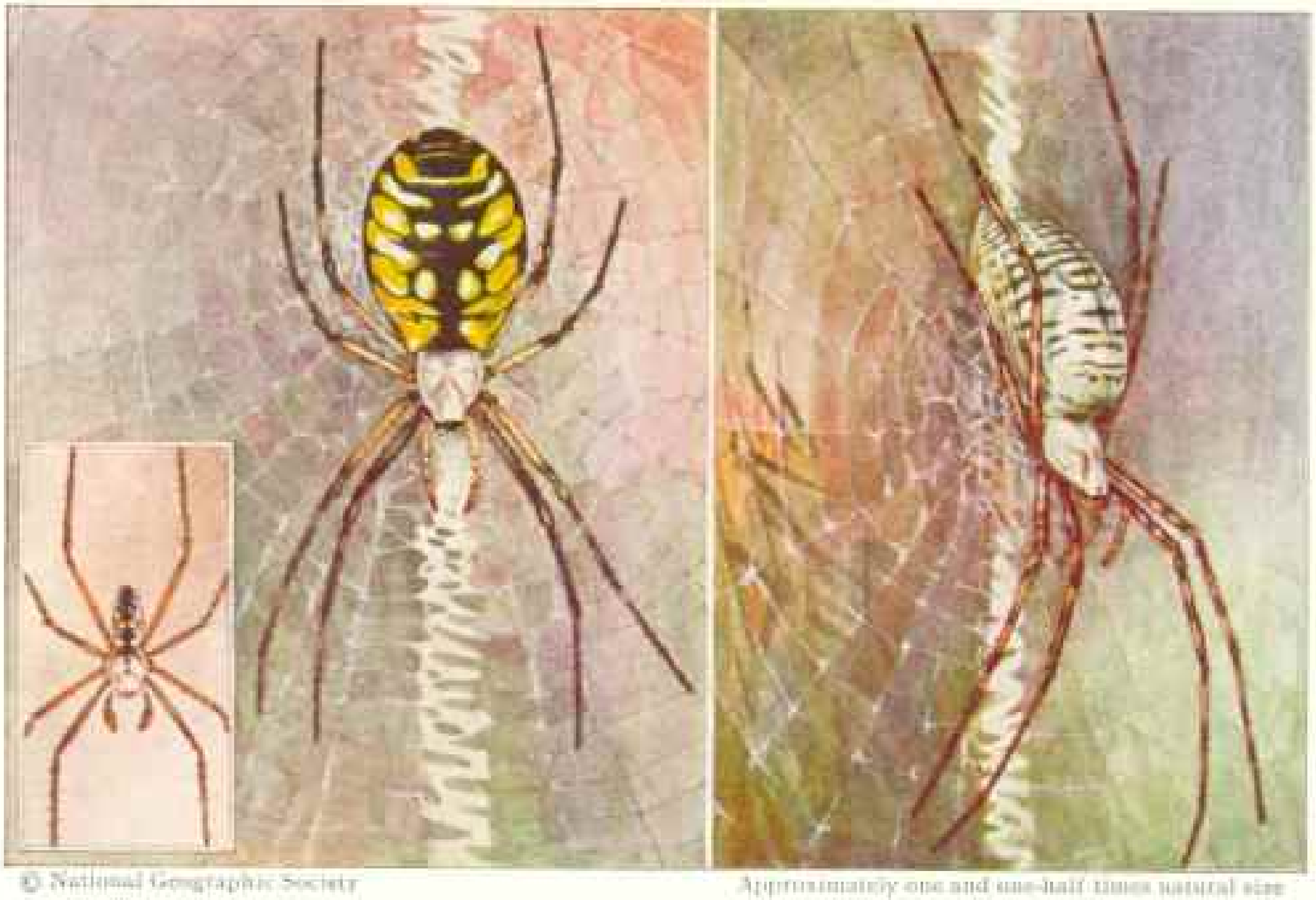
OUR UNWANTED GUEST, THE HOUSE SPIDER, IS AN INTERESTING NUISANCE

More than any other species, *Theridion lepidariorum* is responsible for the irregular, sticky, dust-catching cobweb; but its habits merit study. An adult female (upper left) obliged the artist by posing in the act of pouncing upon a trapped fly. Another, with her shiftless mate below her (upper right), spun some haphazard threads. A third fashioned a silken base (middle left), placed her egg mass within it (middle right), worked down the loose ends (lower left), and finally rested beside her finished cocoon (lower right).

Approximately one and one-half times natural size

HEAVY WITH EGGS, THE FALSE SHAMROCK CLINGS TO HER WEB

One of the showiest of spiders, *Araneus marmoreus*, may be seen in autumn throughout most of North America and in parts of Europe. The female, after laying, becomes much smaller (left inset). She encloses her egg mass in silk (right inset) and then dies.

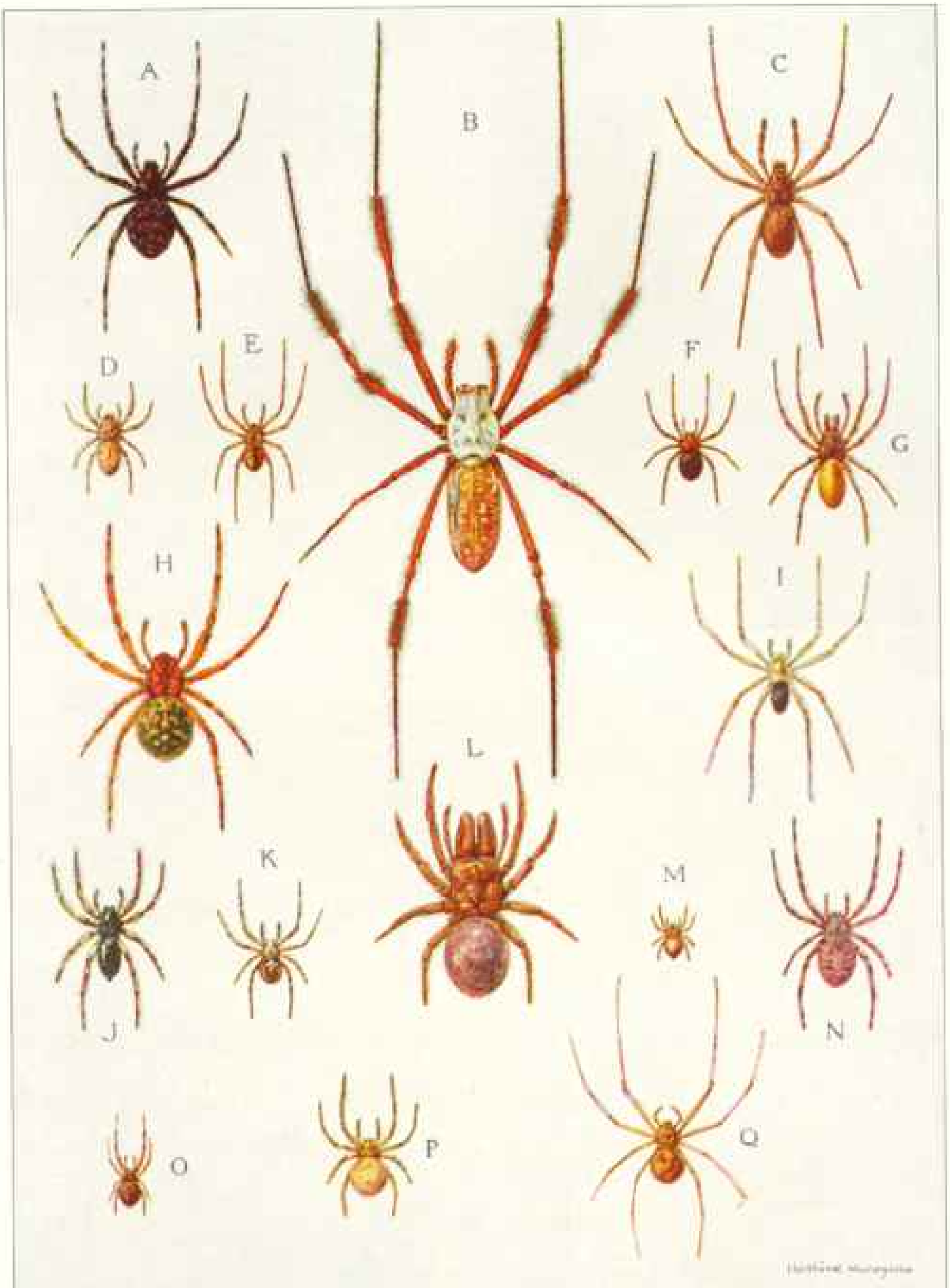


© National Geographic Society

Approximately one and one-half times natural size

GOLDEN GARDEN SPIDERS: BANDED GARDEN SPIDER

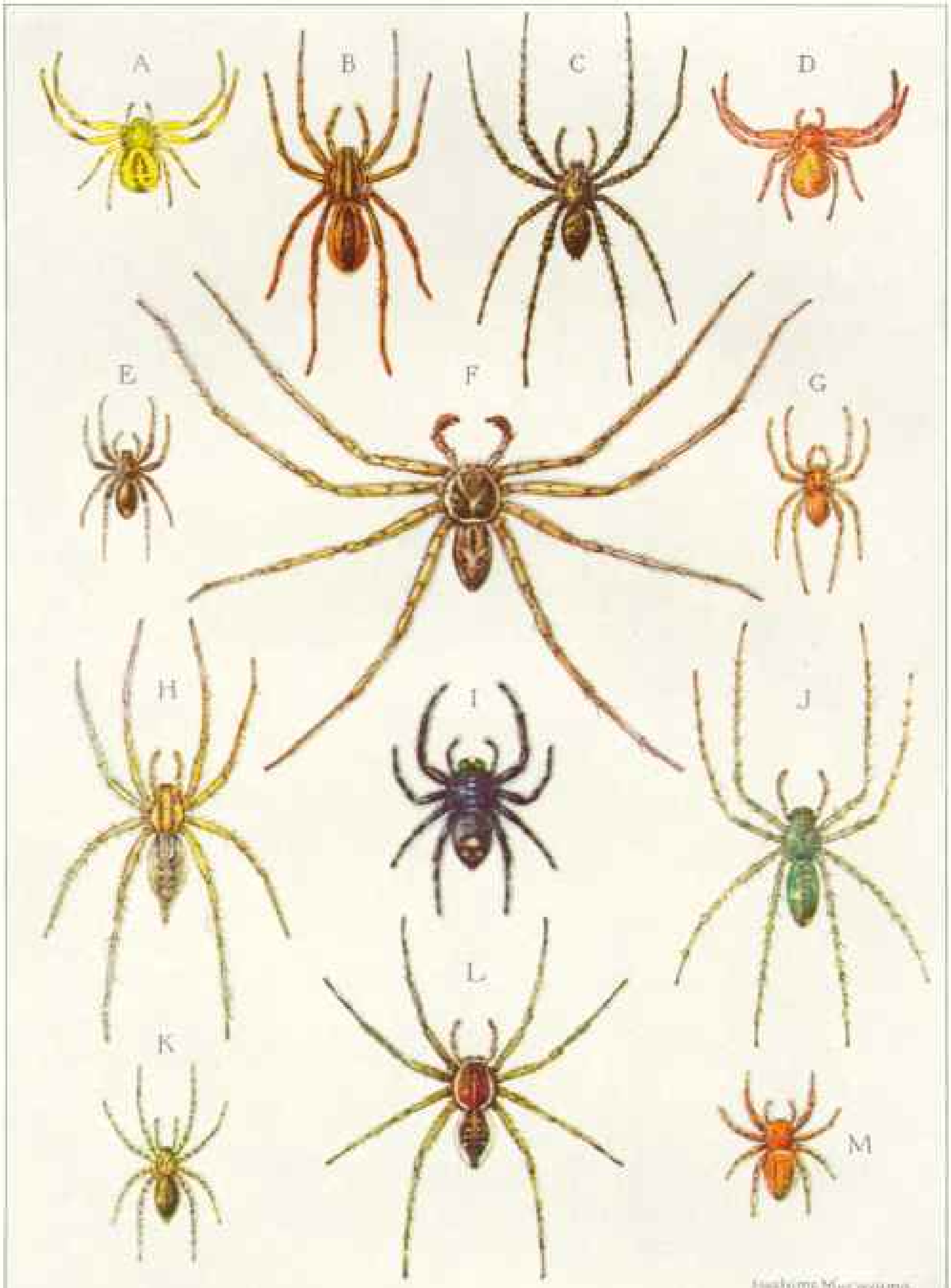
The showy specimen at the left, an adult female, *Miranda aurantia*, weaves a large geometrical net over prize blossoms; but the flower enthusiast forgives her, since she eats plant lice. Her "husband" (inset) seems a puny dwarf. *Metargiope trifasciata* (right) is rarer than her cousin.



Natural size

FABRICS OF MANY DESIGNS COME FROM THESE ASSORTED SPINNERS' LOOMS

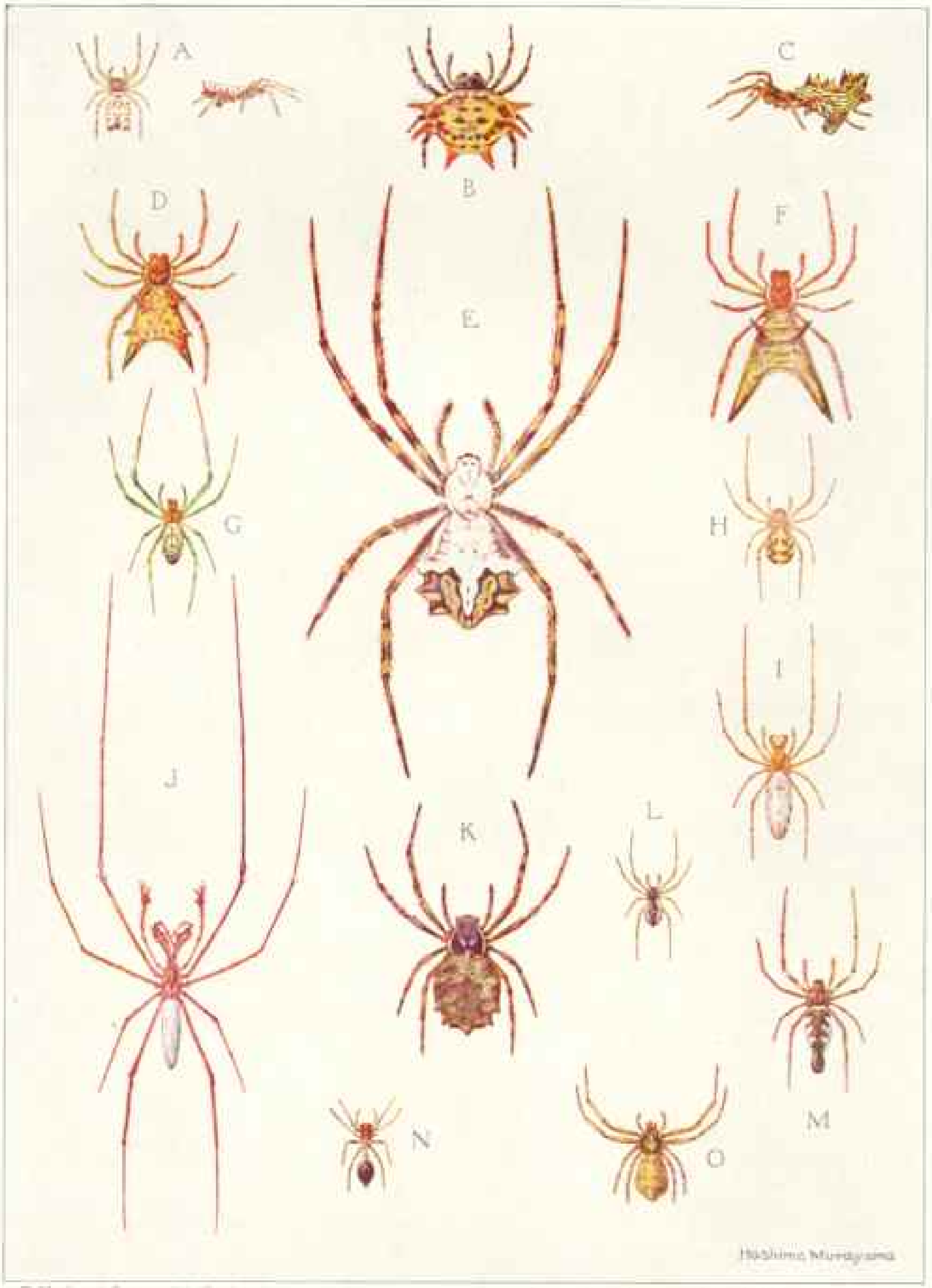
A, *Aranæus benjaminus*, H, *Aranæus bifolium*, K, *Aranæus labyrinthens*, N, *Aranæus vulgaris*, and P, *Aranæus thaddeus*, make typical orb webs. B, *Nephila clavipes*, is a silk spider. C, *Filistata hibernalis*, D, *Amaurobius bennetti*, M, *Hyptiotes cavatus*, and O, *Uloborus americanus*, are hackled-band weavers. E, *Linyphia phrygiana*, spins a sheet, while F, *Steatoda borealis*, produces mere cob-webs, and L, *Atypus abbotii*, fashions a tube. G, *Dysdera crocata*, I, *Loxosceles rufescens*, and Q, *Scytodes longipes*, have six eyes. J, *Zelotes aler*, is a drassid, moss spider. See accompanying article.



 Natural size

MENAGERIE CHARACTERS AND ATHLETES PREDOMINATE IN THIS LOT

A, *Misumenoides aleatorius*, D, *Xysticus limbatus*, and F, *Heteropoda venatoria*, are crab spiders. B, *Lycosa punctulata*, is the wolf, and J, *Peucetia viridans*, the lynx. C, *Dolomedes scriator*, and L, *Dolomedes triton*, excel as divers; and I, *Phidippus audax*, M, *Phidippus clarus*, as acrobats (jumpers). "Brush-footed" describes E, *Castaneira descripta*, and "Wandering" G, *Anahita punctulata*. H, *Agelena naevia*, and K, *Coelotes fidelis*, fall into the group of funnel weavers. Descriptions appear in the accompanying article.



 Approximately one and one-half times natural size

PERFECTLY HARMLESS DESPITE THEIR FORMIDABLE APPEARANCE

A, *Micrathena reduviana*, B, *Gasteracantha cancriformis*, C, *Micrathena gracilis*, D, *Micrathena sagittata*, and F, *Micrathena obtuscospina*, are spined spiders. E, *Argiope argentata*, is a garden spider. G, *Leucauge venusta*, and its relative M, *Leucauge ingens*, weave horizontal orb webs. H, *Tetiana triangulata*, contents itself with cobwebs. The spiny-jawed species are represented here by I, *Tetragnatha laboriosa*, and J, *Tetragnatha elongata*. Others on the page are a typical orb weaver, K, *Araneus stellatus*; a sheet-web weaver, L, *Linyphia communis*; a mimic, N, *Synemosyna formica*; and a crab spider, O, *Tmarus angulatus*. The accompanying article gives descriptions.

Spiders were navigating the skies just as they do to-day millions of years before man invented the gas-filled silk bag with which he first soared above the earth.

The spider's balloon, like man's, is of silk; but, much simpler, it needs no gas. When its filmy threads are let out they catch the upward currents of air, and thus carry away the tiny aviator. Some spiders, by taking advantage of trade winds, have floated out over oceans and reached islands hundreds of miles from any continental shore.

Spiders may balloon at any time of the year, but it is in October or November, when harvests have been gathered and the golden haze of Indian summer tinges upland and lowland, that the season is at its height for the flight of baby spiderlings. Breaking from the prison walls of their cocoons, they scatter quickly, as if impelled by wanderlust.

Each climbs to the top of some elevated object, and during the heat of the day lets out many filmy strands of silk. As these float upward and away they lift the spinner's abdomen. Then more silk is spun.

Out and out it goes, until finally the spiderling is seen clinging to his perch only by the tips of his legs, so strong is the pull of the silken balloon. Now a little more silk and away goes the aviator, over fields and meadows, over pastures and woodlands, to his future home.

THE ORIGIN OF THE TARANTELLA

Late in the Middle Ages southern Europeans became obsessed by an unreasoning and unreasonable fear of spiders. They dreaded particularly the European tarantula, a medium-sized wolf spider, *Lycosa tarantula*, the bite of which was supposed to cause dizziness and nausea, followed by depressing melancholy and eventually death.

Popular superstition held that only the "medical" choreographers could save *tarantati* (bitten persons). If only the right tune could be found, music and the dance would do the trick. The choreographers professed ability to select suitable music for any "patient."

Skipping and cavorting "with great vigor and variety of steps" made the patient perspire freely, and supposedly the deadly poison left the body with the perspiration. In the wild antics devised to shake off the dread tarantism originated a charming dance, the tarantella.

Superstition and quackery gave way slowly before scientific experiments that proved the tarantulas of Europe really rather harmless. But meanwhile the white settlers of America had come in contact with much larger and more ferocious-looking spiders. The American spiders would kill little snakes, or toads, or even birds. Naturally these fearsome creatures, though actually Aviculariidae, were called tarantulas and made the object of the same fears and superstitions that had held in Europe.

We know to-day that there is little justification for fear of our true tarantulas. One member of this group, however, the giant *Sericopelma communis* of Central America (see Color Plate II), appears to be an exception in regard to its venomous nature.

ONE VENOMOUS CLAN IS HEADED BY THE BLACK WIDOW

Although science has exploded most of the exaggerated fears of spiders in general, it has convicted as dangerously venomous one small group, the genus *Latrodectus*, found throughout most of the warmer countries of the world.

The best-known representative of the clan in the United States is the black widow, *Latrodectus mactans* (see Color Plate III), somewhat common in the South, rare in the North.

These spiders are rather closely related to the common house spider, *Theridion tepidariorum* (see Color Plate IV), belonging, as they do, to the same family, the Theridiidae; but they have greatly enlarged poison sacs, and the venom they inject is more potent than that of a rattlesnake!

Fatal cases affecting man are rare; yet numerous fatal cases of *Latrodectus* bite affecting domestic animals have been recorded recently in foreign countries.

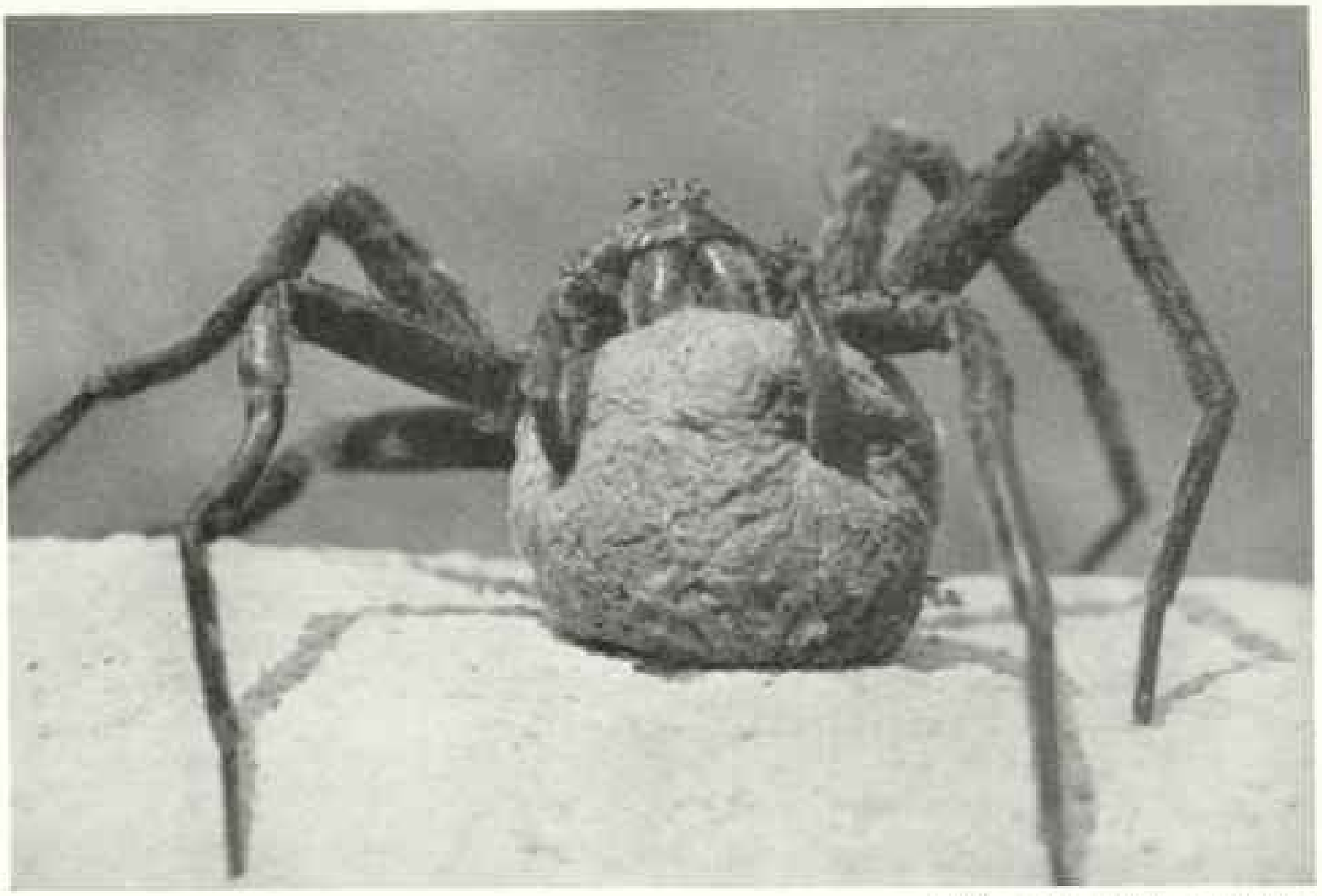
Black widows occur in Nature under old logs, about the bases of tree trunks, under loose bark, and in other dark places near the ground. About human habitations they more commonly are found in stables, outhouses, and basements.

The bite of the female (the male is not known to bite man) is followed by a sharp pain. A small white spot soon appears surrounding each puncture point. Within half an hour aching pains arise in other parts of the body, frequently followed by cramped breathing. After a bitten patient is put to bed, some fever may develop, pains become intense, and delirium ensue.

Photograph courtesy U. S. Department of Agriculture

A CEREUS PLANT NEAR KANDY, CEYLON, SUPPORTS A SILKEN COÖPERATIVE APARTMENT

Community spiders, unlike most other species of the spinners, are gregarious and enjoy close association with their fellows. They spin their webs together, often completely covering a large shrub or even a tree.



Photograph by Lynwood M. Chace

MATERNAL INSTINCT IS STRONG AMONG THE SPIDERS

That precious sac—not for one moment will the mother part with it. Females of some species place their eggs on the webs and stand guard over them. Others constantly carry the silk-encased masses in their jaws or tied to the tips of the abdomens. This member of the Dolomedes clan holds her burden with her palpi.

Recovery is nearly always within two weeks (see illustration, page 179).

By careful inspection, premises usually may be cleared of this spider. Not only the live individuals, but also the round, whitish egg sacs, which are placed in the irregular web of the female, should be destroyed. Close screening tends to keep them out of basements.

SPIDER SILK FOR MAN'S USE

The possibility of the utilization of spider silk in the textile industry was investigated in France more than two centuries ago by Bon, a pioneer enthusiast, who collected a large number of spider cocoons, obtained a quantity of very fine gray silk from them, and made of it some daintily colored stockings and gloves. When he exhibited his product before the Academy of Sciences of Paris, that body was so much impressed that in 1710 it commissioned the entomologist Réaumur to investigate the possibilities of utilizing spider silk as a textile.

Réaumur began his inquiry with high hope and enthusiasm, but when he had finished it he was compelled to recognize certain insurmountable difficulties.

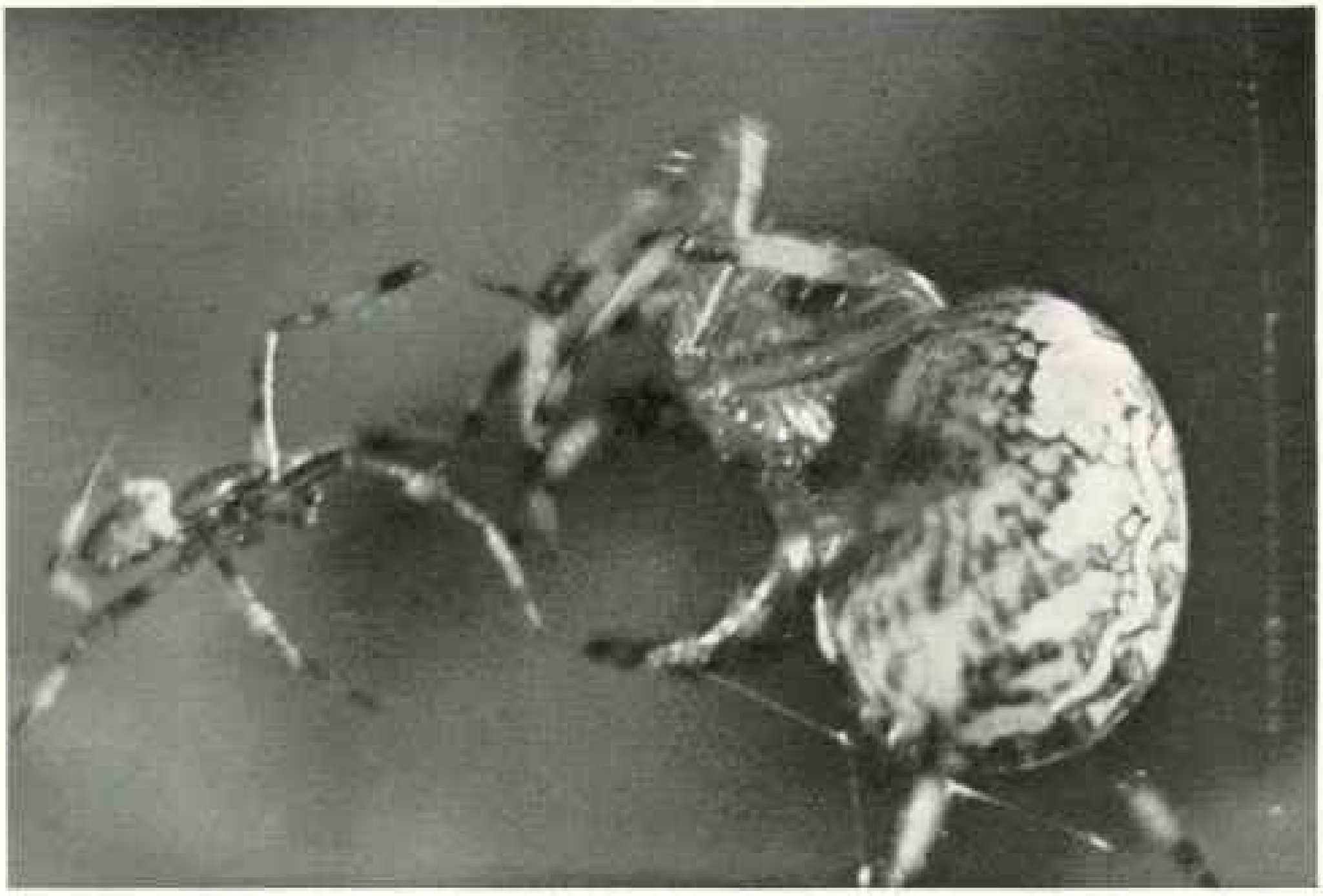
The spider silk was inferior to that of the silkworm; the so-called cocoons, in reality merely egg sacs, which only half of the spider population would produce, contained disappointingly little thread; and the spinners themselves were carnivorous, irritable, and belligerently opposed to crowding. It was almost impossible to provide them with enough food of the proper kind, and to isolate individuals so as to keep them from fighting.

Since Réaumur, others have taken up the problem of finding a way to utilize spider silk. Professor Wilder, stationed in South Carolina as an Army surgeon during the Civil War, became interested in the spinning ability of our brush-legged spider, *Nephila clavipes* (see Color Plate VI, B), and made extensive investigations. He sought to obtain the thread, not from the cocoons, but directly from the abdomen of the spider.

Devices for reeling the threads from spiders had already been made by others,

EVEN THE HUGE BUMBLEBEE FALLS VICTIM

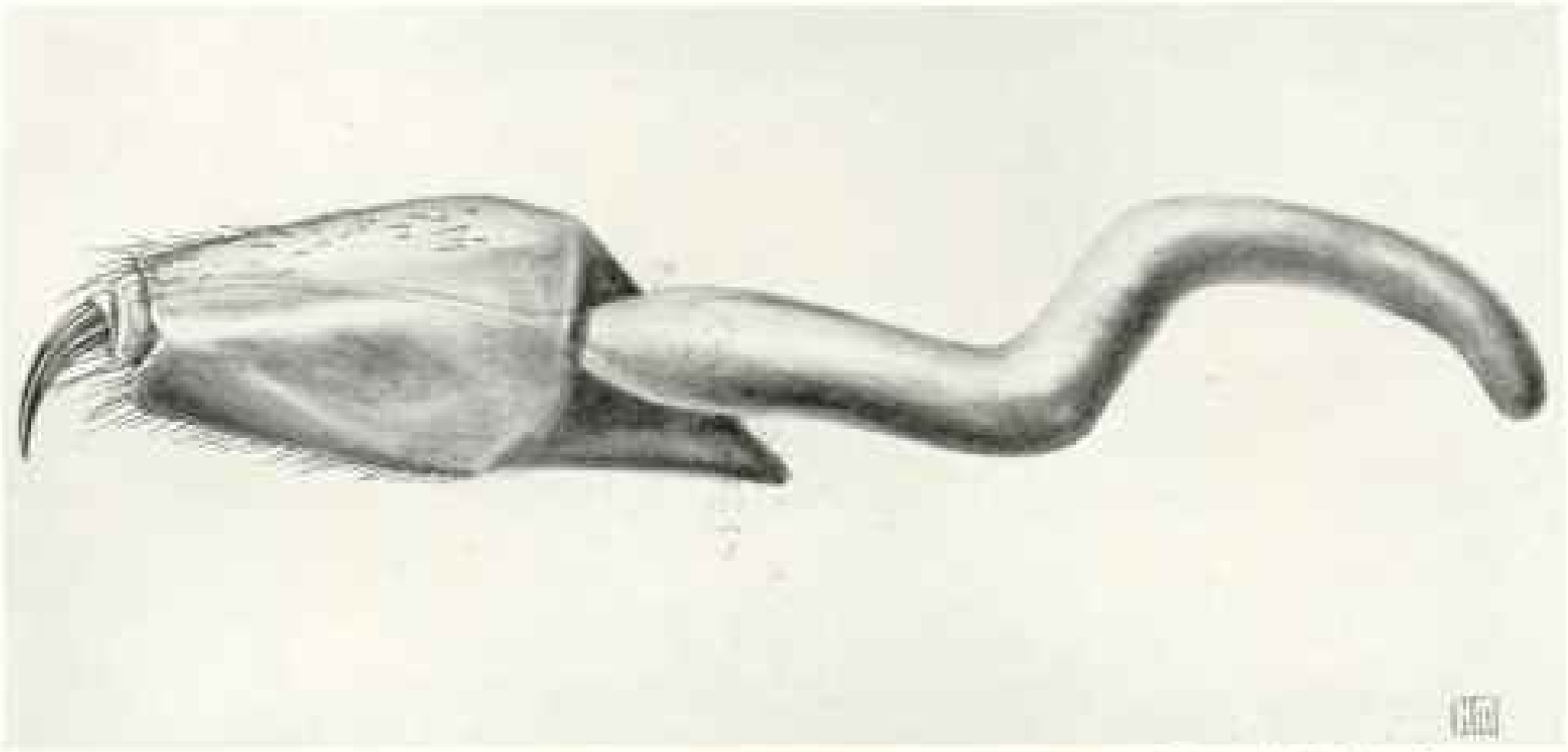
The golden garden spider quickly binds her struggling catch with silk from her spinnerets. After draining the juices from the huge carcass, she will cut the thread holding it to the net and let the empty shell fall. Her indolent mate may feed on what she leaves.



Photographs by Lynwood M. Chace

SPIDERS SOMETIMES HAVE MARITAL DIFFICULTIES

"Husbands," being much the smaller, usually get the worst of it in family fights. However, stories about females luring unsuspecting swains into their webs to gratify hunger have no foundation in fact. After the mating, the male of this pair of the Araneus clan may be devoured, but more likely he will become merely a boarder in the household.



Drawn by Hashime Murayama

OVERSIZE POISON APPARATUS MAKES THE BLACK WIDOW DANGEROUS

In many species, even in the dread tarantula, the sacs which conceal the venom are contained within the jaw structure, but in *Latrodectus mactans* (see Color Plate III) these repositories, of which each individual has two, extend far back of the jaws.

but he improved upon them. He computed that one spider would yield at successive reelings a grain of silk, that 450 spiders would produce enough thread for one yard of silk, and that 5,400 would produce enough silk for a lady's dress.

Although spider silk proved impractical for textile use, the improvement of optical instruments brought with it a real commercial need for the silk in making a precision device. In range finders, certain types of microscopes, and other optical instruments, it was highly desirable to have the circular field of vision precisely divided by as fine a line as possible. For this purpose a thread of spider silk was the best to be found.

Spider silk, used as cross-hairs in optical instruments, is taken in autumn either directly from the abdomen of the arachnid or from its cocoons. It is reeled out on open cards, which are filed away for future use. For this purpose orb weavers are used, three of the favorite species being *Epeira diadomata*, *Zilla atrica*, and *Miranda aurantia* (see Color Plate V, lower left).

When spider silk is obtained directly from the abdomen of the spider it is usually observed to be composed of several strands. Quite frequently four such strands, coming each from one of four specialized glands, make up the thread. A skilled worker can split such a thread into its four components and get a fine element for use in instruments. Spider silk retains its elasticity for months, or even years, and when cross-hairs are in position in an instrument they may remain in use for many years.

WATER SPIDERS AND SNAKE CATCHERS

Although spiders are typical air-breathing animals, a few species have acquired the remarkable ability to descend beneath the water and remain there for long periods. The diving spider takes down with it an "oxygen tank" in the form of a large air bubble, which surrounds the whole of the abdomen and much of the cephalothorax.

A foreign species, *Argyroneta aquatica*, builds among aquatic plants a dome-shaped air container, where it devours its prey, casts its skin, mates, and lays its eggs. Fresh air is carried to this submerged domicile in bubbles brought from the surface.

One observer reports seeing a 6-inch garter snake caught in the web of *Tentana triangulosa*. Although the snake had not yet stopped writhing, the spider was feeding on it, and the sucked tissues were bloody, soft, and pulpy. The snake weighed 8 grams, the spider only 0.0225 gram after its full meal.

RELICS OF THE PAST—LIPHISTIIDAE, AVICULARIIDAE

The valiant arachnid had successfully caught a victim more than 350 times its own weight.

Photograph by Lynwood M. Chace

NO HOPE FOR THE FLY CAUGHT IN THE SPIDER'S JAWS

Fortunately for the victim, the poison which flows from the fangs will bring quick insensibility and death.

The most generalized of the spiders are the tarantulas and their kin. They breathe through two pairs of book-lungs and have powerful jaws that work up and down in a vertical, longitudinal plane. Their stout bodies are usually well clothed with hair and some Asiatic species have segmented abdomens.

These spiders live on or in the earth, make no snares for catching their prey, and are largely nocturnal. Some of them, called trapdoor spiders (see Color Plate I), protect their tunnellike nests with hinged doors.

Tarantulas occur in the warmer parts of the world. Our common Western tarantula, *Eurypelma californica* (see Color Plate II), active at night only, passes the day in its hole. As has been shown experimentally, its bite is of no serious consequence; yet its fangs are powerful enough to bring a flow of blood. Individuals of this tarantula may live 14 to 16 years, or even longer, growing during most of the time.

Our common Eastern trapdoor spider, *Pachylomerus audouini* (see Color Plate I), digs a deep hole in the ground, lines it with fine silk, and finally adds a waferlike lid of the same material as that surrounding her home. The lid is held together with silken threads and sticky material and hinged with threads of silk. Not to be confused with the California trapdoor spider (see page 195), this species is found from Maryland to Texas.

TUBE-WEB SPIDERS—ATYPIDAE

Members of the family Atypidae have been called atypical tarantulas. They are similar in shape to the true tarantulas, but are smaller and less hairy and have more conspicuous jaws. Like the tarantulas, they dwell largely in holes in the ground,

Photograph by Lynwood M. Chace

NIGHT HANGS JEWELS IN DAINTY PATTERN ON THIS WEB

The shamrock spider (see text, page 189) weaves a symmetrical orb design that lends itself to dew adornment.

but the linings of the holes are continued above the surface of the soil as silken tubes. Our most common species, the purse-web spider, *Atypus abbotii* (see Color Plate VI, L), extends its tube upward from the ground for several inches. The species is found in isolated colonies in the Eastern States, but is more common in the South.

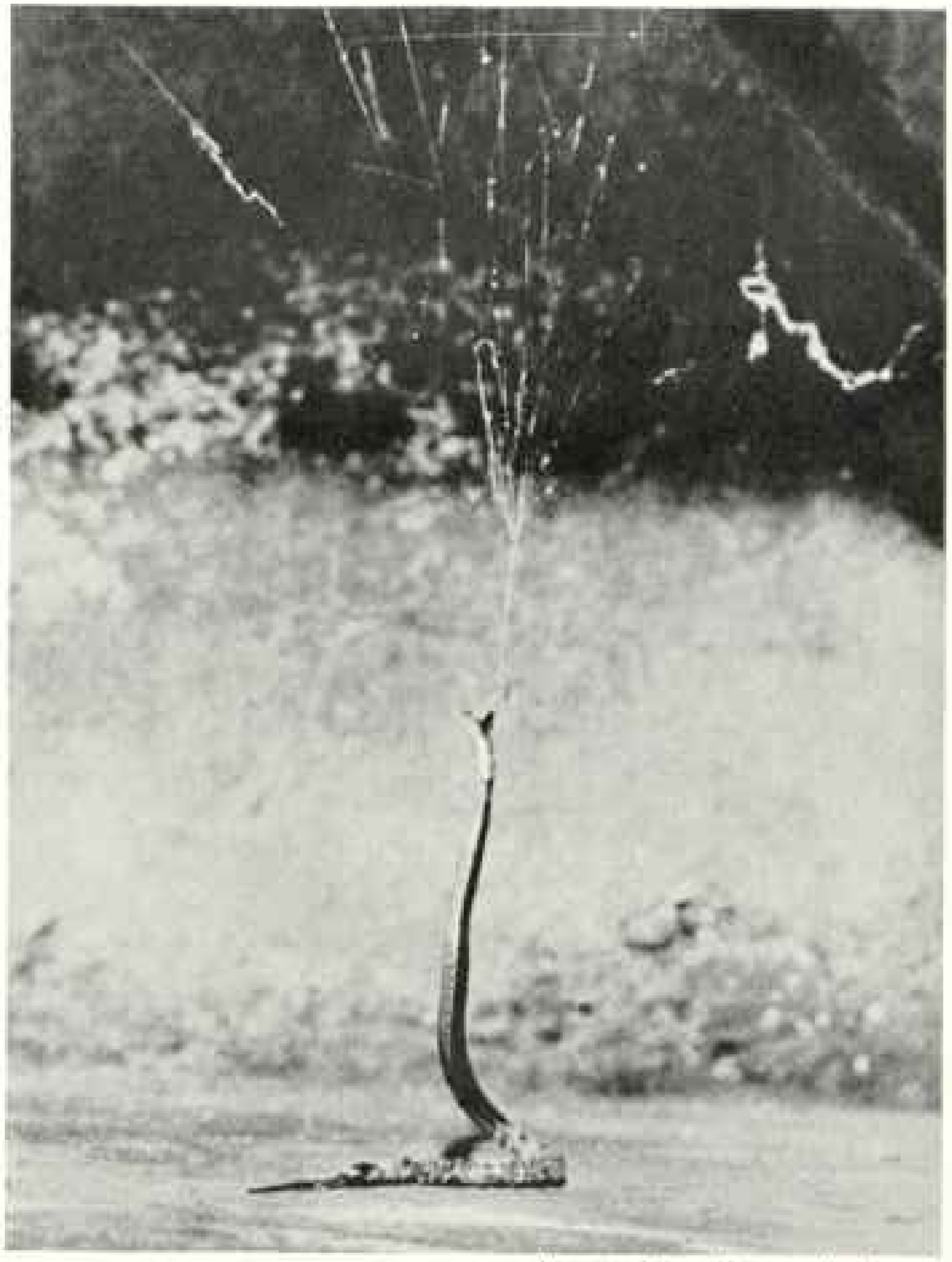
HACKLED-BAND WEAVERS—ULOBORIDAE, DICTYNIDAE, FILISTATIDAE

Pictures of inaction and desolation are never complete without spider webs stretched across some of the débris. That small geometrical web on the weeds near an abandoned farm building is the lair of an odd-looking spider of the species *Uloborus americanus* (see Color Plate VI, O). Her brushlike front legs are out of all proportion to the others.

The triangle-shaped web on the half-dead currant bush, looking exactly like a section of an orb web and having four radii and a complement of transverse strands, belongs to the triangle spider, *Hyptiotes cavatus* (see Color Plate VI, M).

Let us look closer at this web. Now we see a single line of thread running from the apex of the triangle to a twig. At the twig end of this line is the spider herself, holding fast to the twig, and pulling on the line of silk until there are loose folds between her legs. We soon see what she is up to—all set to throw a trap. When an insect touches the web she lets go of the line, and the rebounding web throws its sticky strands against the victim.

The old cellar walls of the ruins are decorated with silk-lined holes, each with its radiating strands or bands of silk. Our



Photograph from Keystone-Underwood

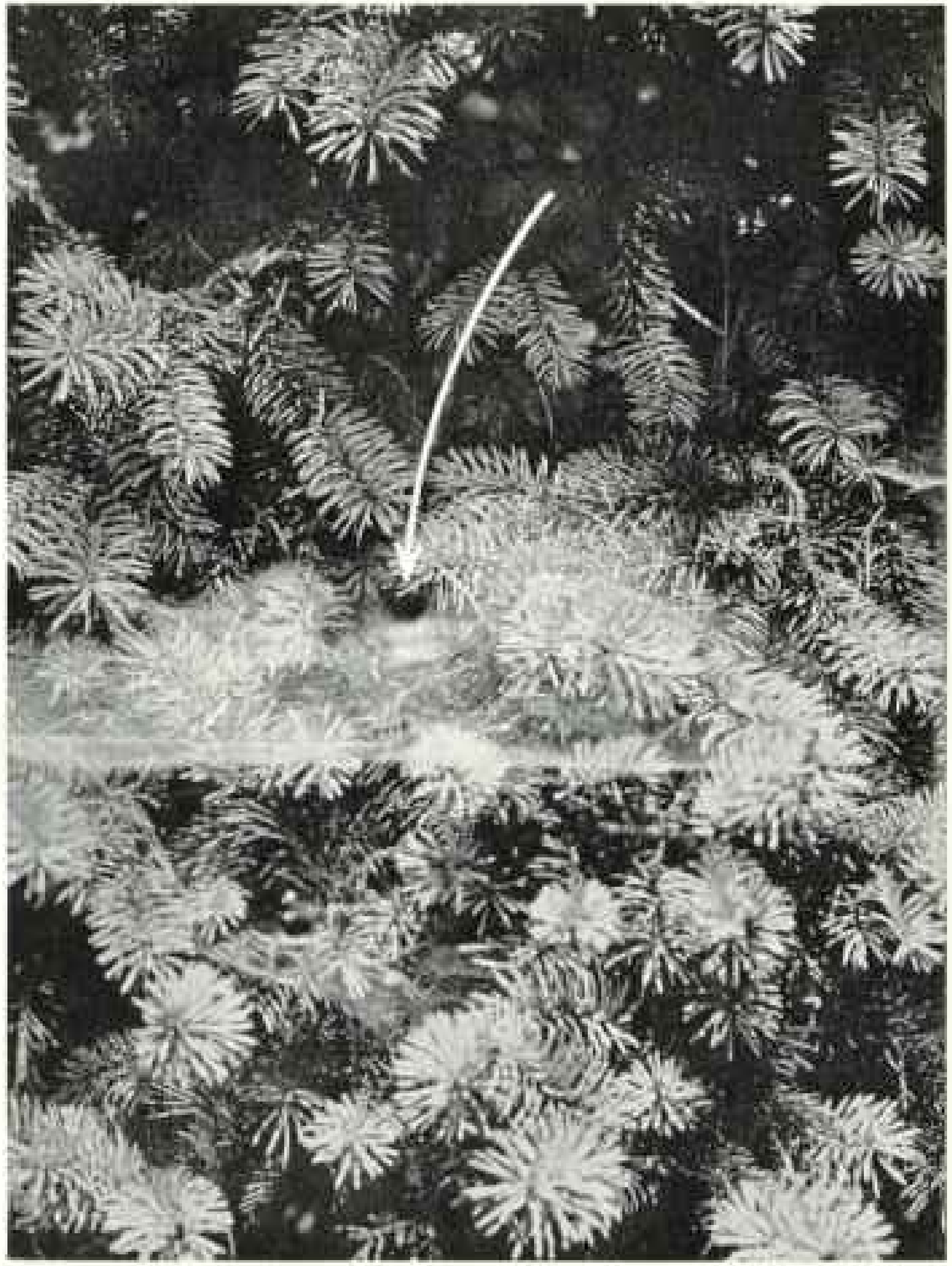
A PAIR OF SPIDERS CONSTITUTE THEMSELVES HANGMEN

This battle was fought in a cellar at Elgin, Illinois. Probably the victim became tangled in the web accidentally as it lifted its head, and the spiders immediately bound it fast with additional threads.

Photograph by George R. King

INSECTS SHOULD HEED THE WARNING

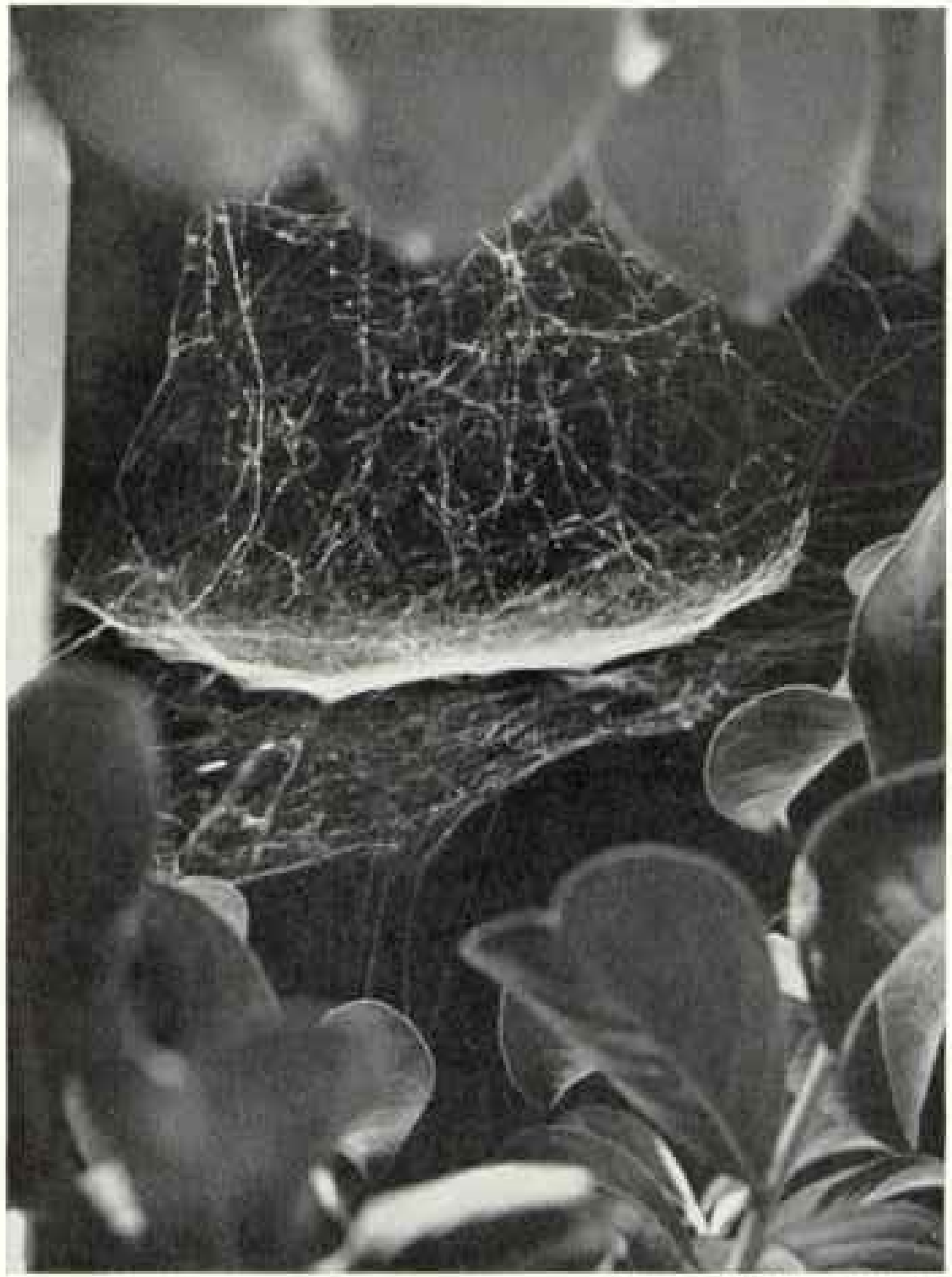
Not only motorists but small-winged creatures have reason to read this sign. The orb web on the left is in perfect condition; that on the right either was abandoned before completion or damaged after construction.



Photograph by Henry E. Ewing

THE GRASS SPIDER WEAVES A FUNNEL WEB

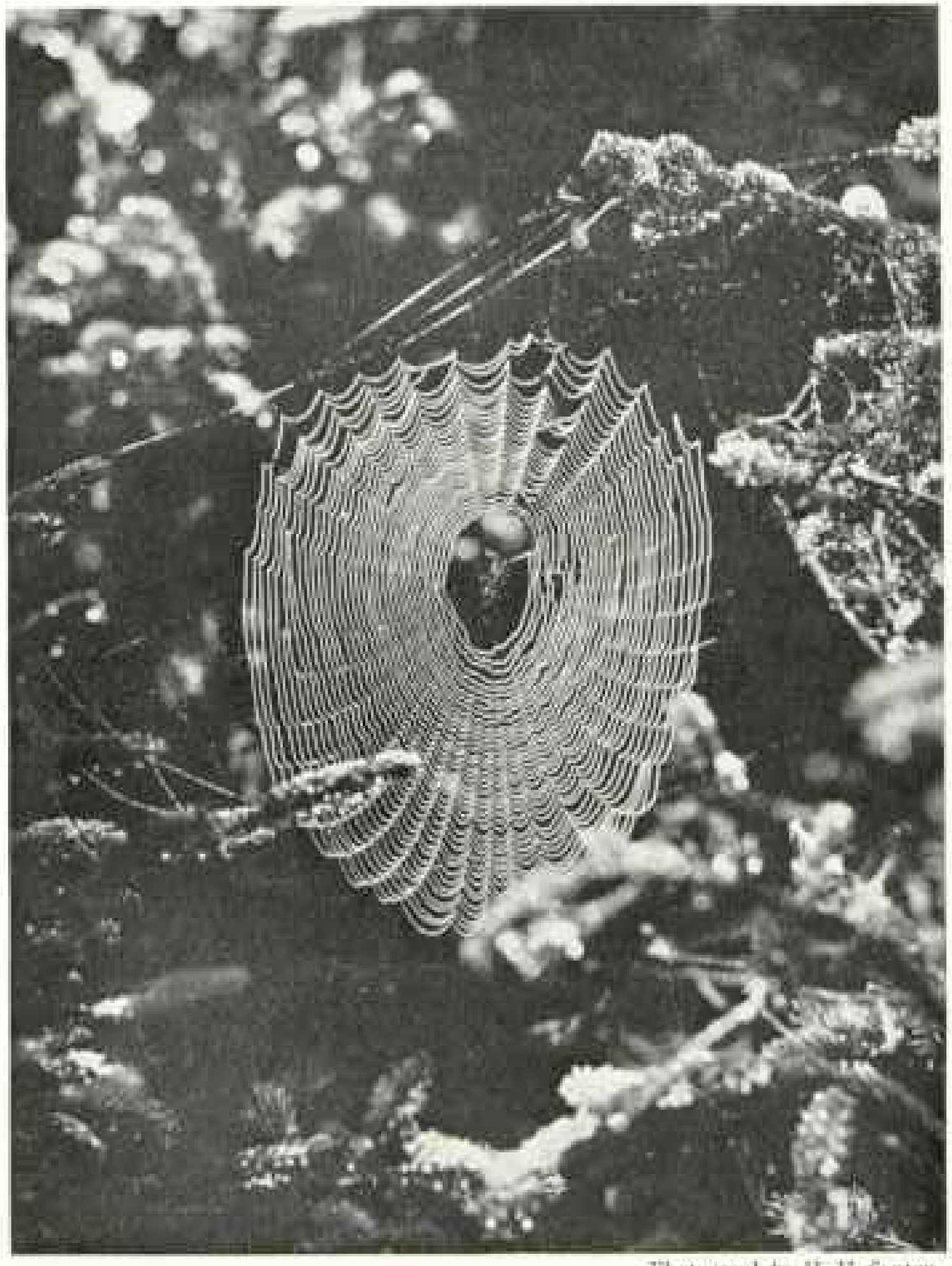
Though her home is usually on lower vegetation, this spinner sometimes builds in evergreen trees, as in this case. She sits near the mouth of the tube (at the arrow point), awaiting her victims (see text, pages 163, 191).



Photograph by Henry E. Ewing

THE BOWL AND DOILY SPIDER WEAVES A DOUBLE WEB

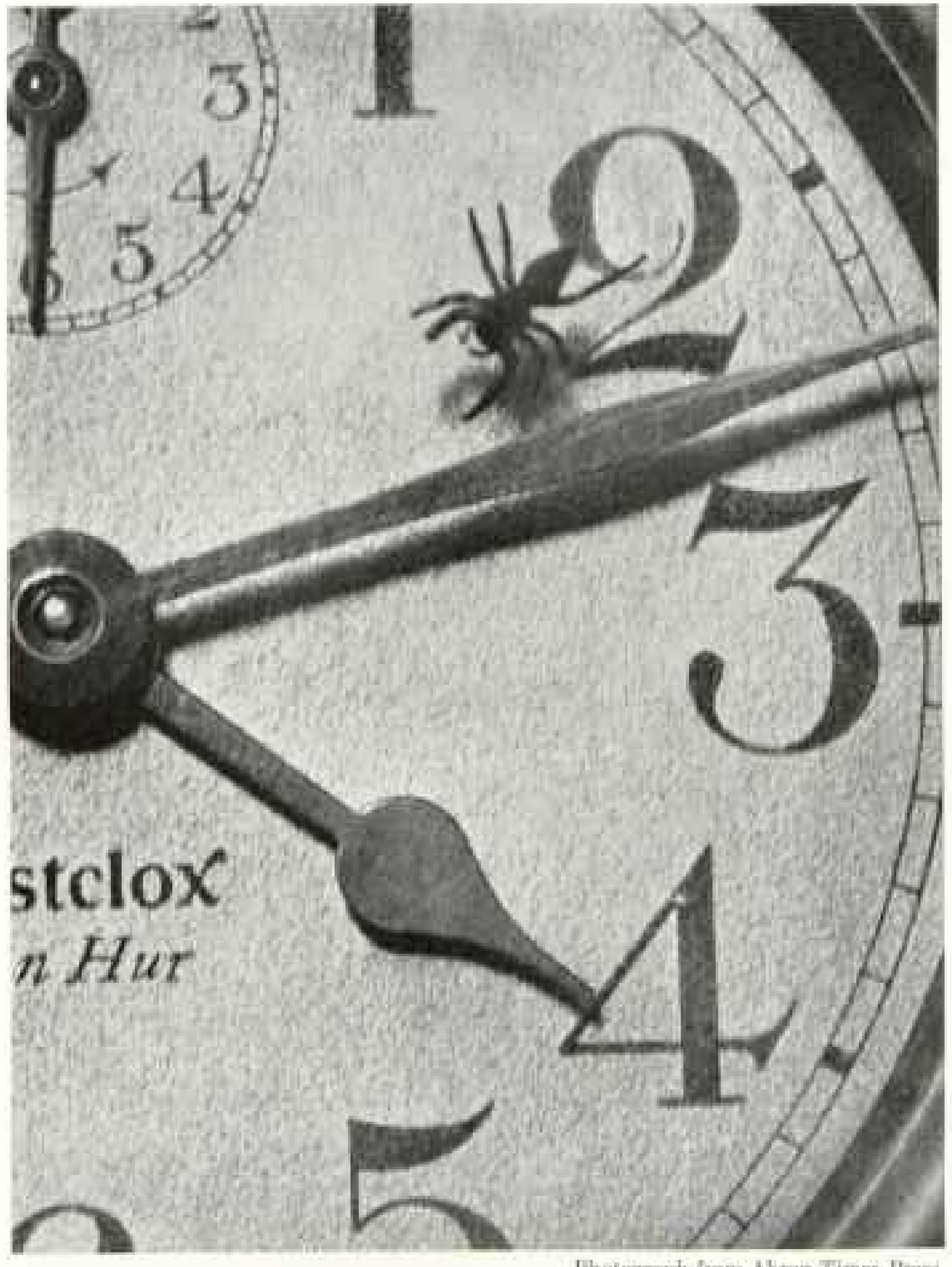
For her filmy home *Linyphia communis* spins two sheets, one above the other. The upper, or "bowl," is concave; the lower, or "doily," is a horizontal plane (see text, pages 163, 187; also compare illustration, page 186).



Photograph by H. H. Seaton

MORNING MIST MAKES A NECKLACE OF PEARLS

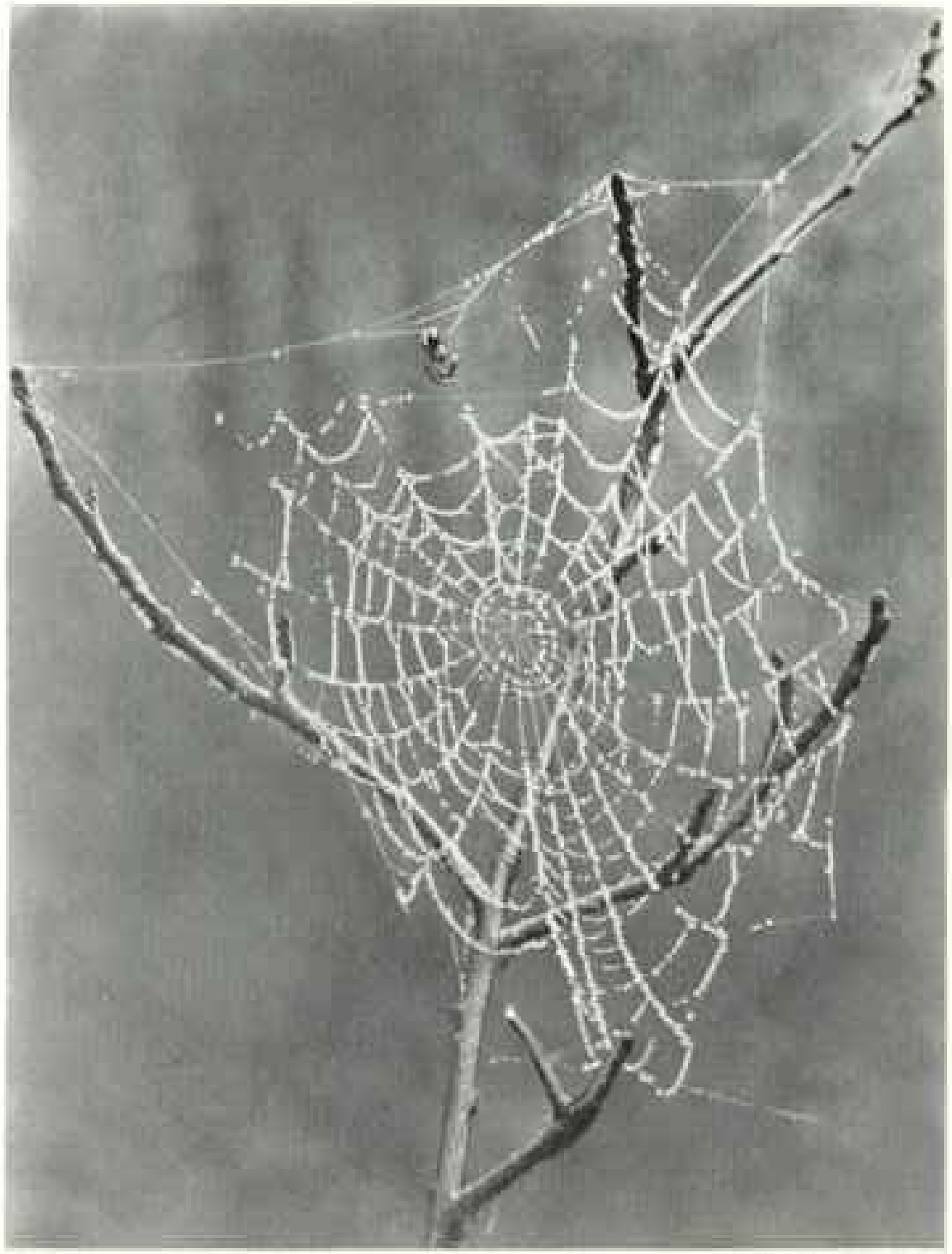
Exquisitely framed in Adirondack evergreens, this symmetrical masterpiece of the orb-weaver's spinning gleams in the sun.



Photograph from Akron Times-Press

TIME AND DISUSE BRING WEBS

When the minute hand comes around again, disaster will overtake this spider unless she relies upon her acrobatic ability to hurdle the moving bar.



Photograph by Herbert

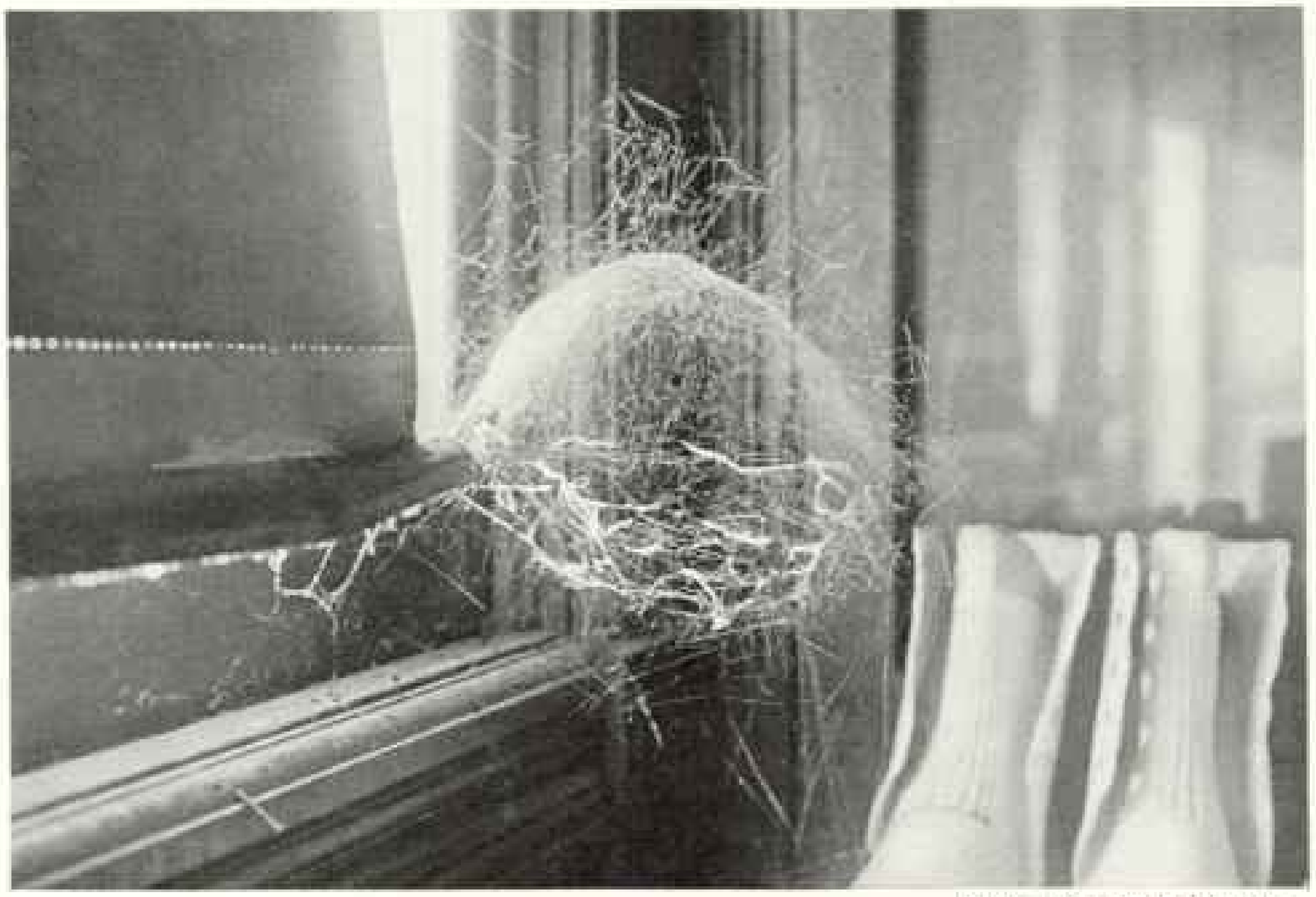
DEW JEWELS THE ORB WEB BUT ANNOYS THE SPIDER

She does not appreciate the pearly drops, for they render her snare useless for catching her breakfast and cause her to go hungry till the sun dispels them.

Photograph by Lynwood M. Chace

ALL SET FOR A DOWNWARD FLIGHT

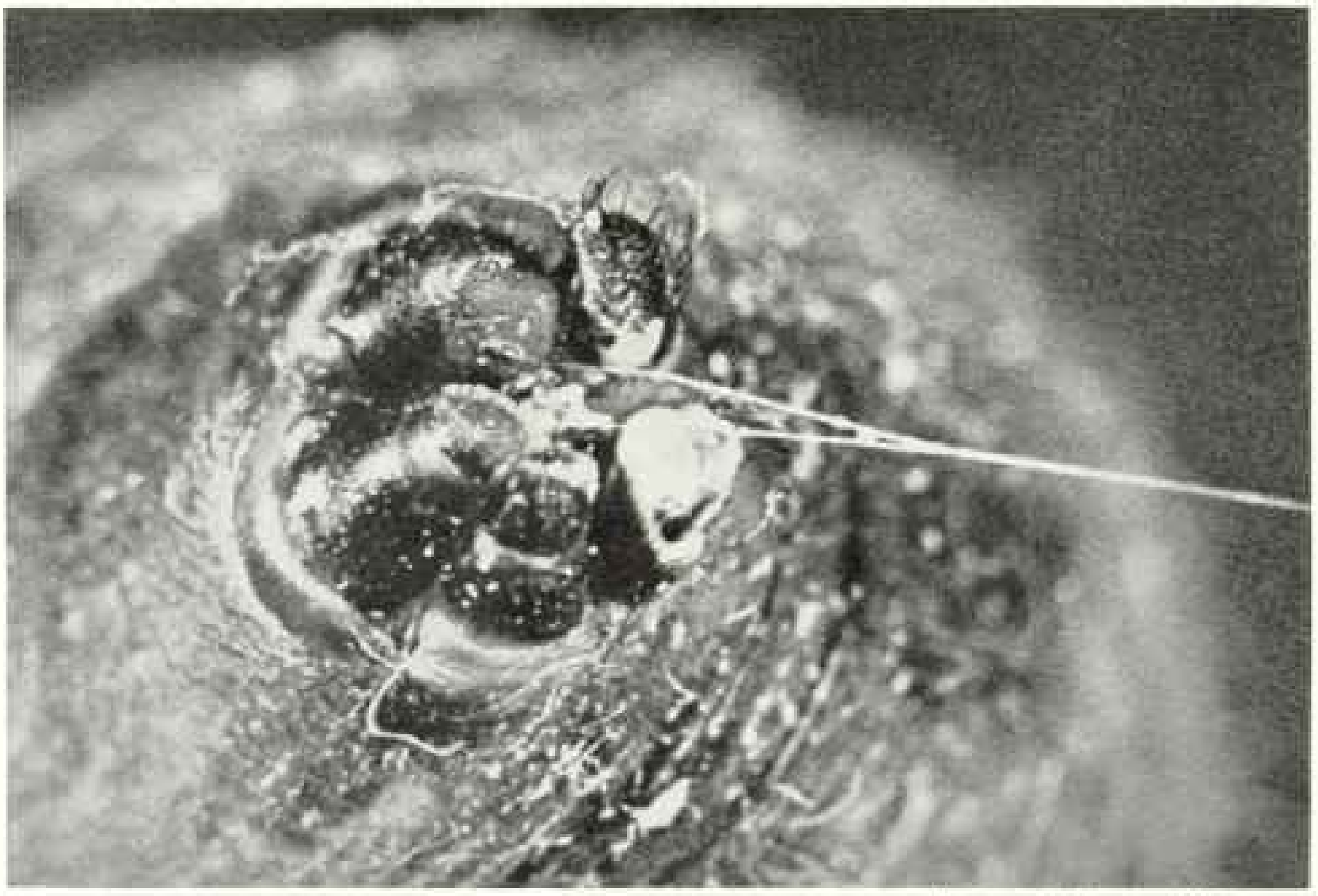
Aranea needs no parachute, for she has attached to a leaf a thread of silk which, as it spins out from her abdomen, will lower her gradually. To return, she will simply reel up her line.



Photograph by W. B. Johnstone

THE SIERRA DOME SPIDER SETS ITS SNARE FOR INSECTS IN FLIGHT

Every species has its own design peculiarly adapted to its needs. *Linyphia litigiosa* spins this inverted bowl; its cousin, *Linyphia communis*, makes a similar trap right side up (see text, pages 163, 187).



Photograph by Lynwood M. Chace

FROM SETS OF SPINNERETS THE SPIDER CONJURES HER SILK

Each of the fingerlike organs (greatly magnified in the photograph) can turn out a thread. Frequently there are not five but six in each group; the one showing white at the right is a fusion of two.

hand lens discovers three or four kinds of silk in the hands. Some of these are made by *Amaurobius bennetti* (see Color Plate VI, D). The most beautiful ones are made by *Filistata hibernalis* (see Color Plate VI, C).

SIX-EYED SPIDERS—DYSDERIDAE, SCYTODIDAE, AND OTHERS

Originally all spiders had eight eyes, but many have lost one or more pairs. A few cave species have lost all of their eyes—an important fact for those to note who believe in adaptive evolution. In *Dysdera crocata* (see Color Plate VI, G) and the other two species here mentioned, there are only six eyes. The eyes of *Dysdera crocata*, all of about the same size, are arranged in a half circle. In *Loxosceles rufescens* (see Color Plate VI, I) the eyes are arranged in three pairs. In the long-legged, subtropical *Scytodes longipes* (see Color Plate VI, Q) the six eyes are pearly white.

MOSS SPIDERS AND RELATIVES—DRASSIDAE

Members of the spider family Drassidae abound in damp woodlands, where they hide under rocks, logs, or in moss. They are eight-eyed spiders, with only two tarsal claws to a leg. The eyes are arranged in two rows. The genus *Zelotes* includes more than a hundred species. *Zelotes ater* (see Color Plate VI, J) has a shiny black abdomen and yellowish brown legs. It is distributed over all of the United States and most of North America.

SOME LONG-LEGGED SPIDERS—PHOLCIDAE

Probably the longest-legged spiders are to be found in the family Pholcidae. One very common species, *Pholcus phalangioides* (see Color Plate III), has such long legs that it is frequently taken for a daddy longlegs.

COMWEB SPIDERS AND RELATIVES—THERIDIIDAE

No journey is necessary to see the makers of cobwebs or irregular nets. The common house spider, *Theridion tepidariorum* (see Color Plate IV), is the most easily observed representative and is present in all countries of temperate climate.

While we are studying the house spider we may find some irregular strands of silk in the lower angle of a window with a specimen of *Teutana triangulosa* (see Color Plate VIII, H) on them. This spider has a strong hankering for the lower angle of a window.

Most of the makers of the irregular nets deserve our confidence and friendship, though the venomous members of the genus *Latrodectus* should be left alone. The false black widow, *Steatoda borealis* (see Color Plate VI, F), may frighten the timid or uninformed, but this near relative of the black widow, *Latrodectus mactans* (see page 175), is entirely harmless.

SHEET-WEB WEAVERS—LINYPHIIDAE

One summer, at my Maryland home, a bowl and doily spider, *Linyphia communis* (see Color Plate VIII, L), made her web on a sweet-pea vine directly in front of the porch swing. Whenever I rested in the swing that summer I had a ring-side seat for observing this dainty little sheet-web weaver. She built a snare composed of two sheets (see page 183), one above the other. The upper sheet was strongly concave and the lower flat and almost horizontal. The female clung to the underside of the "bowl," ready, when a victim was snared, to force her fangs or her entire body through the silken mesh.

A near relative of the bowl and doily spider is our hammock spider, *Linyphia phrygiana* (see Color Plate VI, E), which constructs a netted sheet more or less quadrangular and suggesting a hammock.

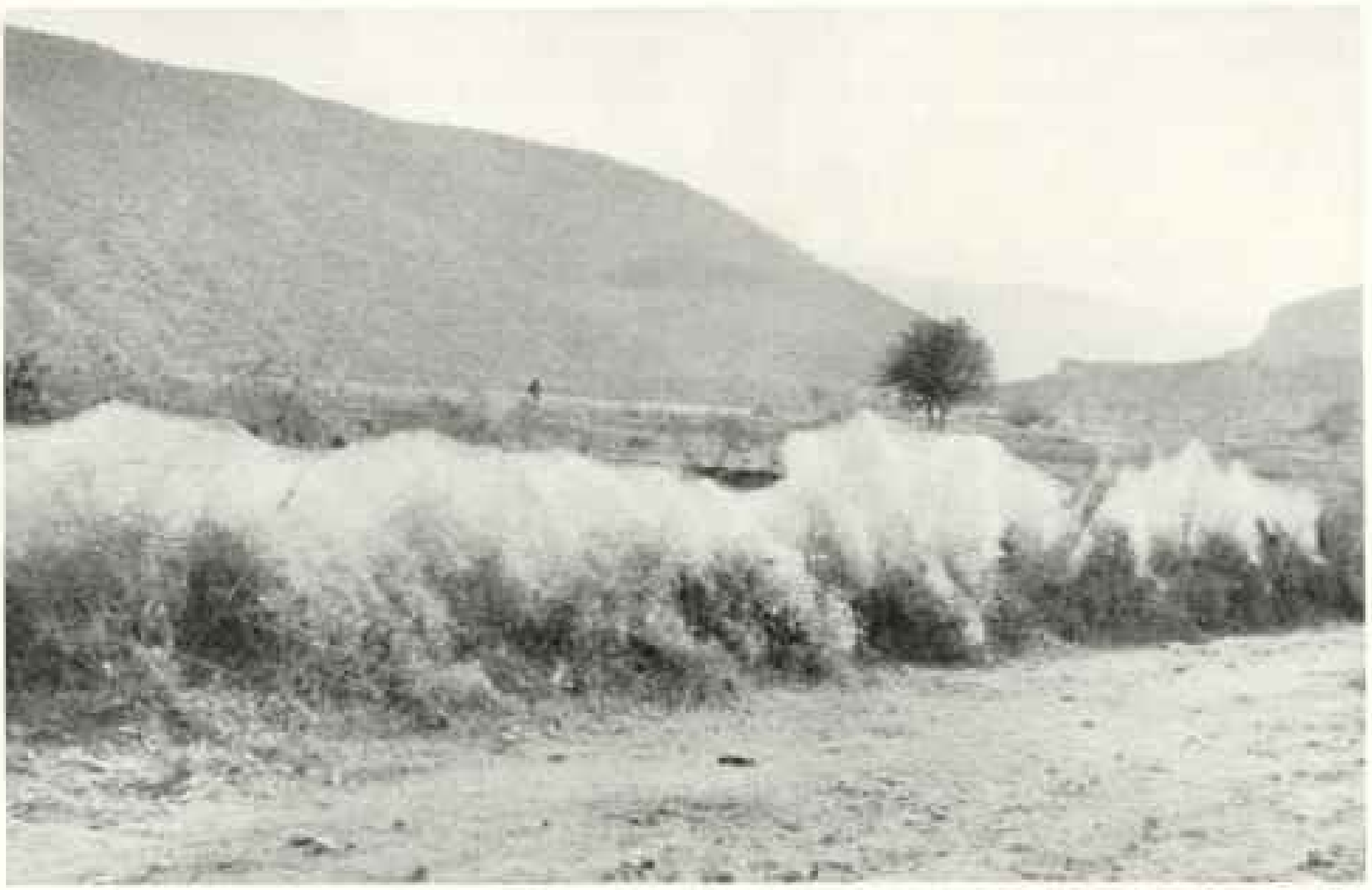
SPINY-JAWED SPIDERS—ARGIOPIDAE; TETRAGNATHINAE

The spiny-jawed spiders, particularly the males, are remarkable for their jaw development. The jaws are not only much enlarged, but are thrust out in front of the body and provided with conspicuous spines. Most spiny-jawed species are rather small; yet to their little victims they must appear most ferocious.

Tetragnatha laboriosa (see Color Plate VIII, I) is common in meadows, where it spins an orb web. It is distributed from Alaska to the West Indies. The extreme characteristics of the spiny-jawed spiders are exhibited in *Tetragnatha elongata* (see Color Plate VIII, J), a species found in damp situations throughout the United States and most of North America.

A HORIZONTAL ORB-WEB WEAVER AND ITS RELATIVES—ARGIOPIDAE; METINAE

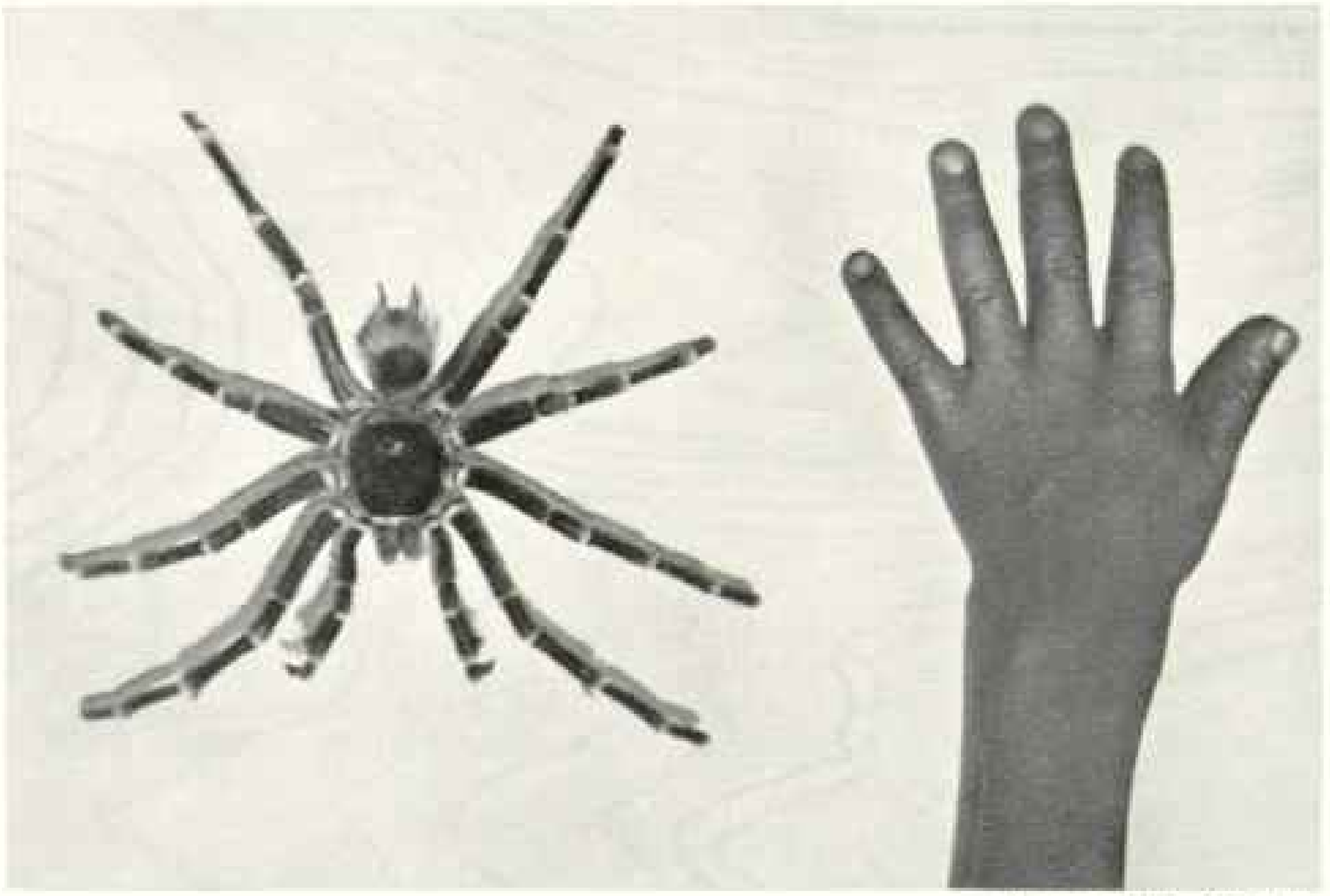
One August morning, in a sunshiny woodland lane near the Potomac River above



© Lieut. S. E. Richardson, R. A. F.

GOSSAMER BLANKETS ENHANCE THE CHARM OF THE SILKEN EAST

In the Hangu Valley, India, spiders spread their filmy lace so thickly over large patches of low-growing vegetation as to conceal the foliage. Dew does not form here; the whiteness of the webs is due to the extraordinary multiplicity of the strands.



Photograph by Hugh B. Cott

WITH A SPREAD LARGER THAN A BOY'S HAND, THE MALE BRAZILIAN TARANTULA LOOKS FORMIDABLE

His fuzzy tentacles are not so thick as at first glance they appear, the light stripes being shadows. From the sides of the jaws extend the palpi, by which mating is accomplished—two leglike projections with ends resembling feet.

Great Falls, I came upon many finely spun, beautifully woven orb webs placed almost or entirely in horizontal position. Looking closely at some of these webs, I found a most exquisitely colored spider. It was a bright green with an elaborate design of silvery white, tinted with gold, and spotted below with coppery red.

This spider beauty was *Leucauge venusta* (see Color Plate VIII, G), one of the most strikingly decorated of all our spiders. It has a Mexican cousin, *Leucauge lugens* (see Plate VIII, M), in which the beauty is marred by the presence of a peculiar taillike projection at the tip of the abdomen.

SILK SPIDERS—ARGIOPIDAE; NEPHILINAE

All spiders spin silk, but members of the subfamily Nephilinae spin so much that they have been used in the attempts to establish a spider-silk industry (see text, page 177). The one well-known species found in the United States is the brush-legged spider, *Nephila clavipes* (see Color Plate VI, B). No spider is more easily recognized than this large orb weaver. Each leg, except those of the third pair, bears one or more whorls of fine setæ, so arranged as to suggest a bottle brush. A foreign species of the same genus, *Nephila*, was once observed catching a bird in its web (see page 190).

GARDEN SPIDERS—ARGIOPIDAE; ARGIOPINAE

When I was a boy in the Middle West I observed a garden spider that spread its beautiful geometrical web across my mother's flower bed. The creature's size, its brilliant golden markings, and the expanse of its web compelled my attention.

Although the web was entangled among some of the most prized flowers of the garden, the spider was not disturbed, for young grasshoppers made up most of its diet.

Garden spiders build geometrical webs almost vertical in position and frequently as much as two feet in diameter. The snares, placed on low-growing vegetation, have at the center vertical zigzag bands of glistening white silk. Here the female patiently rests, head downward.

By far the most common species in the United States is the golden garden spider, *Miranda aurantia* (see Color Plate V, below, left). The female is more than an inch long, but the male (see Color Plate V, below, inset) is puny, being scarcely a fourth as long as the female and sometimes only a fiftieth of her weight. Less common is the banded garden spider, *Metargiope trifasciata* (see Plate V, below, right), a whitish species tinged with yellow and conspicuously marked with irregular dark bands.

In the silvered garden spider, *Argiope argentata* (see Color Plate VIII, E), the abdomen of the female is produced laterally into three pairs of large tuberclelike lobes.

TYPICAL ORB WEAVERS—ARGIOPIDAE; ARANEINAE

In open places and among flowers, where there are many flying insects, the typical orb weavers abound. *Araneus benjaminus* (see Color Plate VI, A) is common in Maryland and Virginia flower gardens. Its generic brother, *Araneus vulgaris* (see Color Plate VI, N), also loves the flower garden. The lattice spider, *Araneus thaddeus* (see Color Plate VI, P), builds a beautiful latticelike web, stretched across the underside of a slightly curled leaf.

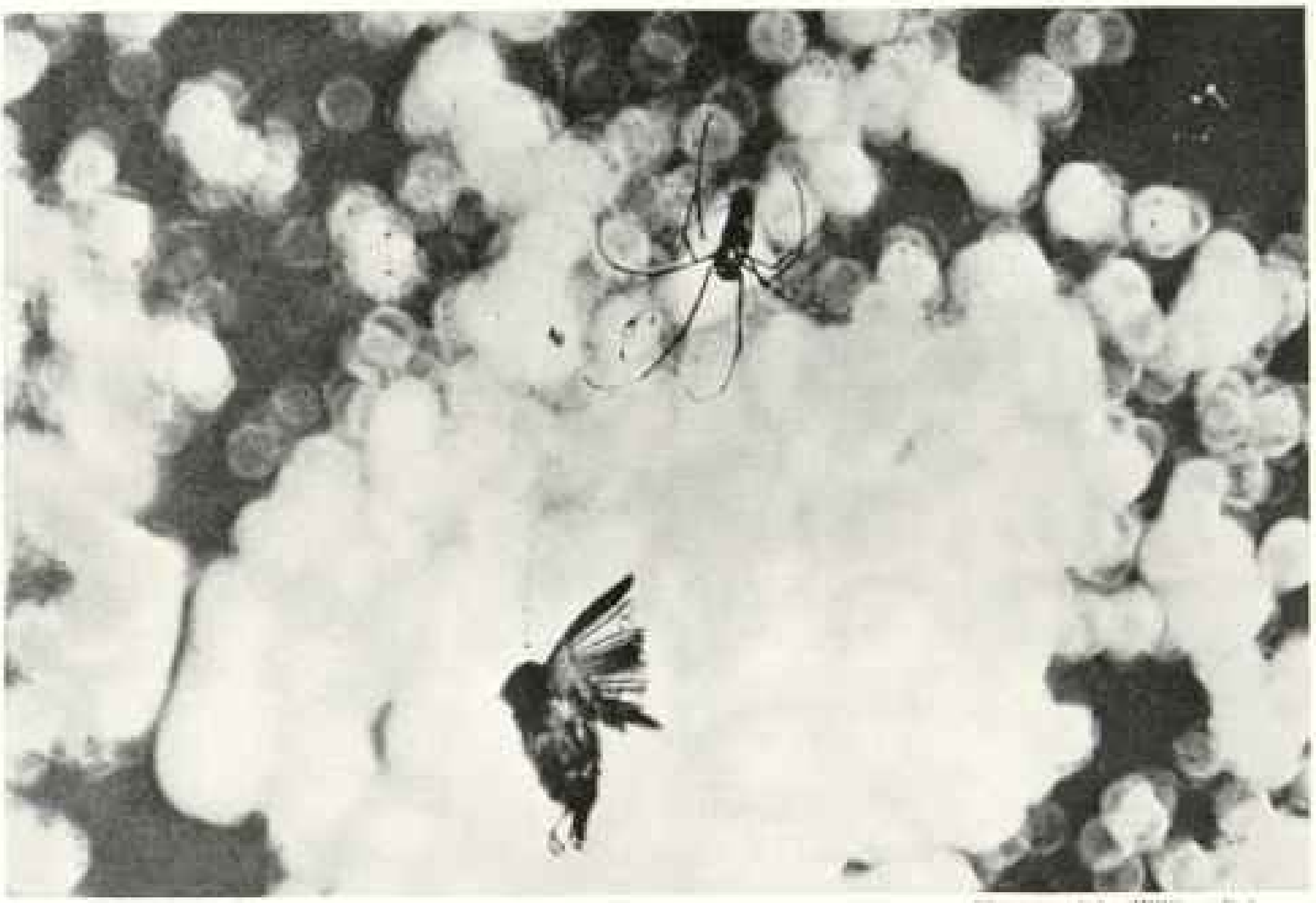
As we pass along the hedges we may find the beautiful labyrinth spider, *Araneus labyrintheus* (see Color Plate VI, K), which builds two distinct types of webs situated together, thus having a composite home.

The most permanent part of this double house is an irregular net of the type built by the cobweb weavers. To this is added an incomplete orb. Near the central part of the irregular net the female builds a retreat and concealment nest of a few small dead leaves tied together with silk.

In a ramble in summer sunshine we may find the star spider, *Araneus stellatus* (see Color Plate VIII, K), which has about a dozen spinelike tubercles around the margin of the abdomen; but to see the gorgeous shamrock spider, *Araneus trifolium* (see Color Plate VI, H), we must make a trip in the autumn. This spider frequently has a three-lobed spot, shaped like a clover leaf, on the middle of the anterior half of the abdomen.

SPINED SPIDERS—ARGIOPIDAE; GASTERACANTHINAE

If you live in one of the Southern States, take a walk in the woods some bright summer afternoon. Suddenly you will come upon a large geometrical web stretched from one branch to another. At the very hub of



Photograph by William Palmer

SUCH JUNGLE TRAGEDY AS THIS, IN JAVA, IS UNUSUAL

Seldom does a snare-weaving spider catch a bird. The little flower pecker has flown into the web of a large *Nephila*.

the web is a black and yellow object resembling a bur. This spined object is the female of the spined spider, *Gasteracantha cancriformis* (see Color Plate VIII, B).

Most of our spined spiders, however, have a longer body than this one and do not resemble a bur so closely. *Micrathena reduviana* (see Color Plate VIII, A) has only two pairs of spines, both very small.

The spear-head spider, *Micrathena sagittata* (see Color Plate VIII, D), has three conspicuous spines. The tropical spear-head spider, *Micrathena obtusospina* (see Color Plate VIII, F), has only two pairs, but they are enormous. *Micrathena gracilis* (see Color Plate VIII, C) has five pairs.

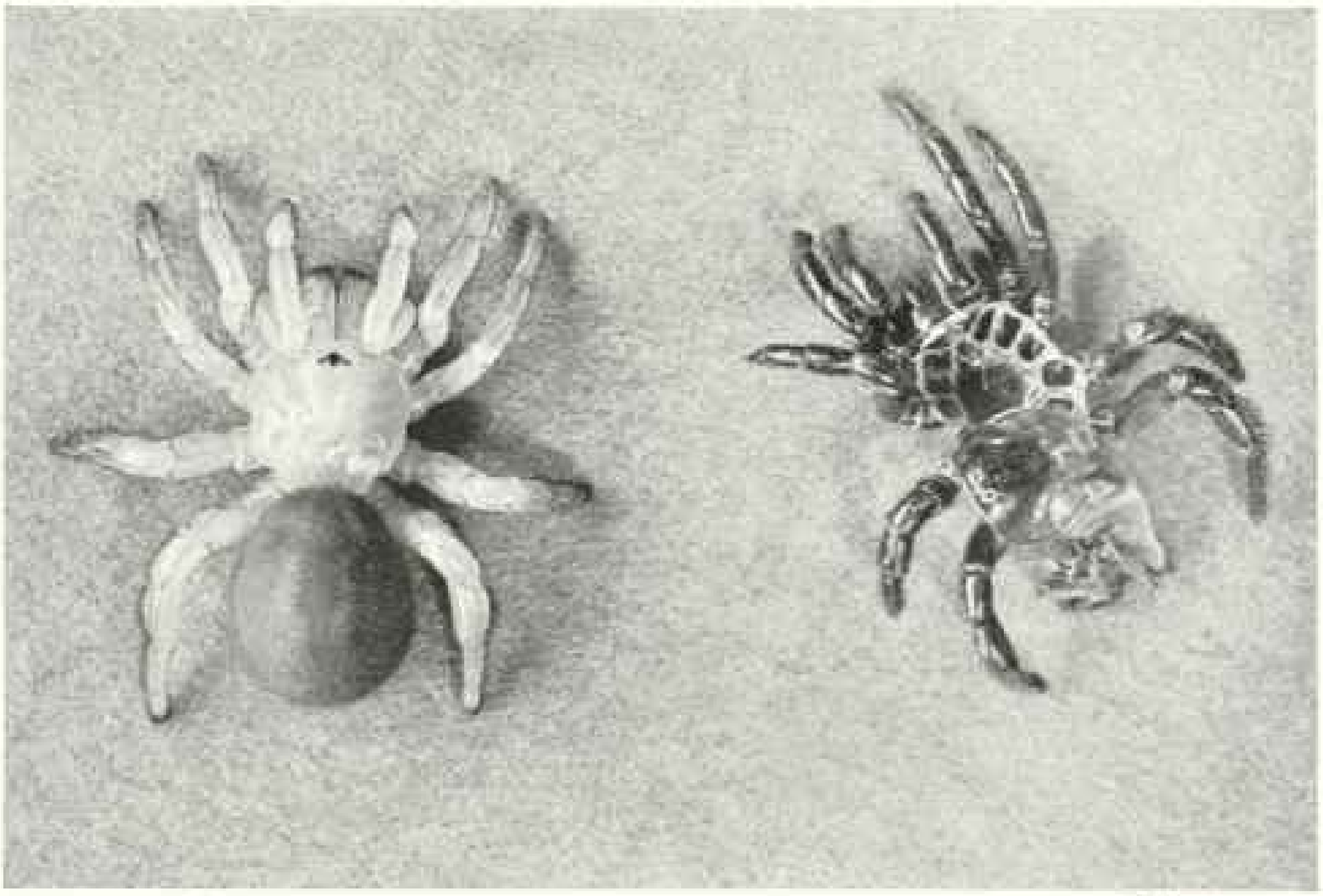
CRAB SPIDERS, LARGE AND SMALL—THOMISIDAE AND HETEROPODIDAE

Crab spiders are so named because of their resemblance in shape to crabs. The likeness results from the flattening of the body and the assumption of a lateral direction by the legs. One species, *Misumenoides aleatorius* (see Color Plate VII, A), lives in flowers. It may be almost uniformly white or yellow or strikingly marked with reddish brown above. This spider has a tendency to take on the color of the flower it inhabits, thus becoming almost invisible.

The genus *Xysticus* (see Color Plate VII, D) includes about a third of all our crab spiders. Members of this genus are usually either fawn-colored or brownish. Their life is spent in seclusion, under stones or the loose bark of trees, or in other situations away from the eyes of enemies. The angulate crab spider, *Tmarus angulatus* (see Color Plate VIII, O), differs decidedly from most of the other members of the family in having the abdomen high and pointed behind.

Related to the true crab spiders are the members of the family Heteropodidae, known as the giant crab spiders. They also have the legs extending laterally from the body.

The best-known member of the group is the large banana spider, *Heteropoda venatoria* (see Color Plate VII, F). This is a tropical species that frequently arrives in our northern cities on bunches of bananas and is commonly mistaken for a tarantula. Its bite is sharply painful, but not dangerous.



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A FEMALE SPIDER FIVE MINUTES AFTER SHEDDING

She appeared like a wax model and was almost transparent, as she rested by her cast-off covering at the right.

The female makes a flat, waferlike egg sac, which she carries about under her body by means of her mouth parts. Once I took an egg sac from a female banana spider and gave her in its place a substitute of the same size and shape which I had whittled out of pine. She readily accepted the imitation sac.

WANDERERS AND STAY-AT-HOMES—CTENIDAE AND CLUBIONIDAE

Spiders of the small family Ctenidae love to roam. One of these ramblers, *Anahita punctulata* (see Color Plate VII, G), is found in the Southern States.

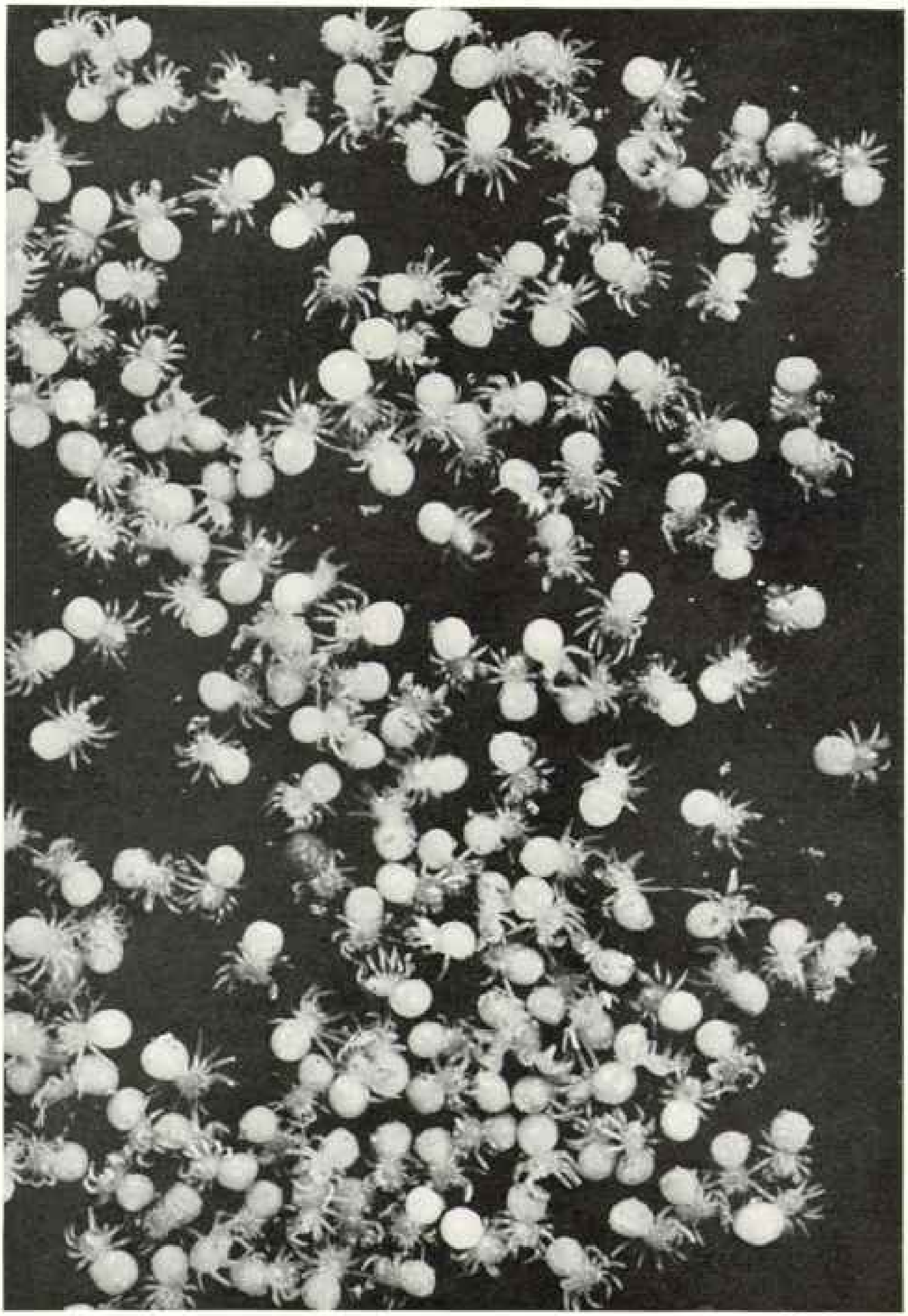
Far different in their disposition are the members of the family Clubionidae. They appear to be possessed of an inferiority complex. One of them will roll up a leaf and hide away in it as if all the world were gloomy and sinister. Another will pick out a cranny in the side of a cliff or wall, seeking in this manner his solace and quiet. Many of the species are less retiring and some are light-colored, with conspicuous black cushions of hairs at the tips of the legs. One species, *Castaneira descripta*, is pictured in Color Plate VII, E.

Funnel-web spiders (Agelenidae) abound in summer wherever there are moisture and vegetation. Usually they build near the ground; or, if far above the ground, in a thick growth of vegetation such as a hedge or an evergreen tree. Our common grass spider, *Agelena naevia* (see Color Plate VII, H), is the best-known funnel-web maker. It is common in many places in the United States. The tube of its web (see page 185) almost invariably leads back into a thick growth of vegetation. Thus, when the spider retreats, it is safe from its enemies.

A small cousin of the grass spider is *Coelotes fidelis* (see Color Plate VII, K), which does not spin a perfect funnel web.

DIVING SPIDERS AND THEIR RELATIVES—PISAURIDAE

Some of the members of the family Pisauridae are called diving spiders. They belong to the genus *Dolomedes* and make interesting aquaria inhabitants. I have kept several individuals of *Dolomedes triton* (see Color Plate VII, L) at different times in large aquaria jars. This species is called the six-spotted diving spider and is the most striking in color and marking.



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NEWLY HATCHED TRAPDOOR SPIDERS RESEMBLE PEARLS EQUIPPED WITH WRIGGLING LEGS

The spiderlings change color as they grow older, becoming pale pink and then a darker shade. A little later, although they are no larger than grains of rice, they can spray a tiny web from their spinnerets and build a miniature nest. Few of the original 300 spiderlings live to maturity. Sometimes the mother will crush one of her offspring between her jaws, so that the other members of her family may partake of the juices. The figures are enlarged about four times.

One female kept in an aquarium, where she had been supplied vegetation above the water, lived for months and made her spherical egg sac. This she held closely in her mouth parts and only once could she be induced to drop it to feed.

Dolomedes urinator (see Color Plate VII, C) is rather somber-colored. It is found in marshy places in the eastern part of the United States.

WOLF SPIDERS—LYCOSIDAE

Spring is the time for wolf spiders. They may be found running through the grass, along woodland paths, and in many other places. They catch their prey by chasing and springing catlike upon victims.

The maternal instinct is best developed in this group. Not only do the females carry their egg sacs with them, firmly attached to the spinnerets by bundles of silken threads, but the young spiders are carried upon their mother's back for days after hatching. *Lycosa punctulata* (see Color Plate VII, B) is a striped species common in the eastern part of the United States.

© Lee Pantmore

A TRAPDOOR SPIDER ON WATCH

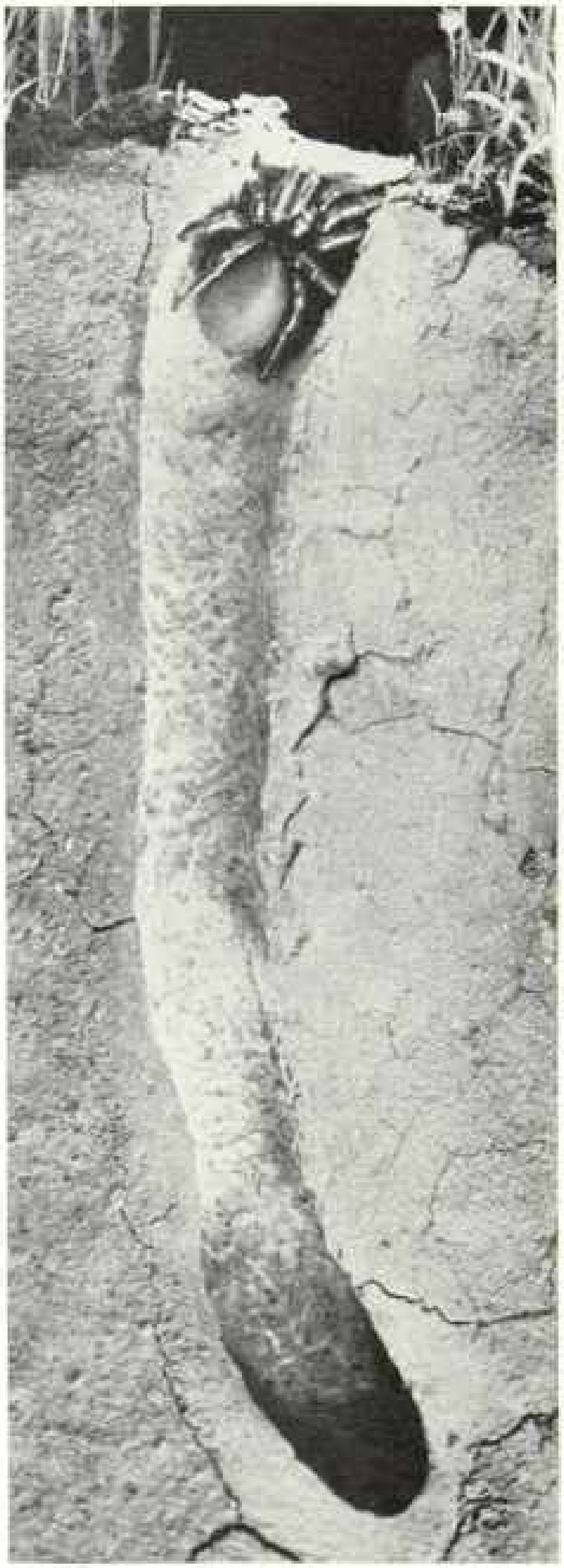
A spider will remain for hours with the lid slightly raised, while she waits for her prey. When the vibrations set up by the footfalls of an approaching insect warn her, she leaps out and grasps her victim. Movement is so rapid the eye can scarcely follow.

LYNX SPIDERS—OXYOPIDAE

Members of the small family Oxyopidae chase their prey swiftly among trees and shrubs, even leaping from one branch to another. Their legs are long and each is armed with three terminal claws. The eyes are eight in number, dark in color, and unequal in size. *Peucetia viridans* (see Color Plate VII, J) is a most beautiful representative of the group. It is a large species, having a bright, transparent green as a background color and markings of red, brown, and black.

ACROBATS AND MIMICS—ATTIDAE

One warm spring morning, as I was passing along one of the drives in the Zoölogical Park at Washington, I saw a large specimen of the audacious jumping spider, *Phidippus audax* (see Color Plate VII, I) sitting on top of a fence post. As I reached out to collect her in my insect bottle, she followed my hand with her eyes. No matter the direction from which I approached, she always changed her position and faced my hand. Finally she was captured and I decided to make a pet of her.



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A TRAPDOOR SPIDER IN HER LAIR

The indentations made by the spider's fangs are visible through the silken lining. The spider is in the position in which she waits under her door for her prey. The soil in which the nest was built was gray adobe. This nest is about two-thirds natural size.

On many occasions this spider attacked and captured victims twice her size. She would pay no attention to a fly until it was within a few inches. Then her eyes would be fixed on the victim, following its every movement for a few seconds. At length a well-aimed leap ended the affair.

Before a jumping spider jumps it always fastens a line of silk to its resting place. Thus, however far it may go over a precipice, it is always safe from a fall. By means of the silken line, it can regain its former position.

In *Phidippus clarus* (see Color Plate VII, M) the female has the cephalothorax and abdomen red, and the male has only the abdomen red, the rest of the body being black.

Certain jumping spiders, as well as other kinds, have a remarkable ability to mimic ants, a fact unknown to me during my early experience as an entomologist.

This mimicry is not usually in appearance only, but frequently it is in the movements of the body as well; and it is not confined to any one family or group of spiders, but occurs in several of them.

Among the jumping spiders, or Attidae, mimicry is probably most prevalent. The mimicry may be confined to one sex or it may involve both sexes. It may be a general imitation (*i. e.*, a spider may take on an external form somewhat similar to that of many ant species), or specific aping by one spider of a single ant species.

In the case of the common ant spider, *Synemosyna formica* (see Color Plate VIII, N), the antlike appearance is brought about by the unusual shape and rather small size of the cephalothorax, which in these respects resembles the ant's head; by the narrowing of the anterior part of the abdomen to suggest the ant's waist; and by attenuation of the front legs, which are held in such a manner as to suggest the antennæ of an ant.

In addition to these changes in form, certain color markings aid in making the deception nearly perfect. Thus the front legs look narrower than they really are because of their white outer margins. The same thing is true of the anterior part of the abdomen.

The advantage gained by this mimicry is important where the mimicked ant species is pugnacious and unpalatable. Some tropical species repeatedly fool experienced entomologists; even a hand lens does not easily aid in the recognition of Nature's deception.

CALIFORNIA TRAPDOOR SPIDER PERFORMS ENGINEERING MARVELS

By Lee Passmore

With Illustrations from Photographs by the Author and F. E. Beck

RETURNING one May evening from a ramble over the southern California foothills, I came across a young man busily digging in a small mossy knoll. He was so engrossed in his work that he did not become aware of my presence until my shadow fell upon the object which was attracting his attention.

With apologies for my intrusion, I asked what he was digging. He turned with a pleasant smile and replied, "Trapdoor spiders."

Then, reaching down into the hole, he handed me a strange tubular object, warning me that it was exceedingly fragile—an exceptionally fine specimen of a cork-type spider's nest.

The burrow, or nest, about ten inches long by one and a half inches wide, was built in adobe soil. Fitting neatly in its upper end was a door, hinged with tough web. The under surface of this cover and the walls of the tube were lined with smooth, silky web of lustrous, velvety appearance.

THE SPIDER HOLDS HER TRAPDOOR SHUT

I had difficulty in raising the door; the owner of the nest strenuously objected!

The spider had placed her two fangs in the holes she had made in the under side of the lid and, bracing herself, held on for dear life. Even after my superior strength had overcome hers, she allowed herself to be lifted partly out of her nest before she let go and dropped back into the dark interior. As soon as I let the door snap into place, she returned and got another grip.

This chance meeting was the beginning of my close association with Francis Beck, who for 13 years has studied the habits of the common California trapdoor spider (*Bothriocyrtum californicum*). So deeply interested was I with the specimen shown me that I gladly accepted his invitation to inspect his collection.

I found him working at his home next day under the trees, where he had placed in a natural setting the many specimens which he had brought from the neighboring hills. Here, in boxes of adobe soil, I saw big spiders, little spiders, young and old, in dozens of "transplanted" nests. There were several hundred young ones, which had been hatched during their parents' captivity from eggs contained in the nests at the time of their removal (see illustration, page 197).

Ever alert and watchful, trapdoor spiders are extremely sensitive to the vibrations of insects as they walk over the ground or moss. They seem to know the right instant to raise the door, spring out, and make a capture. Then, dropping back to the bottom of the burrow, they feast at leisure. Movement is so rapid that the insect is within the grasp of the hungry spider before the victim can escape (see illustration, page 199).

Hundreds of sow bugs and other nocturnal insects relished by the spiders are captured by Mr. Beck and guided over the ground close to the doors of the nests to provide food for his charges.

A trapdoor spider is careful not to let the door close behind her when she is making a capture, for the cover is difficult to reopen, once it snaps shut. The door fits so tightly in the tube that there is only a fine crack where a claw could be inserted to lift it. To forestall being locked out of her own home, the spider always leaves her hind legs and a part of her abdomen under the open door (see illustration, page 199).

PATIENCE AND WATCHFUL WAITING REVEAL INGENIOUS NESTS

Considerable patience is necessary to study the habits of trapdoor spiders. Many hours of watchful waiting and sometimes whole nights pass without even a glimpse of a wary spider. It is discouraging to sit in a cramped position for hours, with eyes concentrated on a particular trapdoor, only to discover that this is one of the nights the spider is not inclined to labor.

On many occasions we have returned home after tramping for miles over good spider territory without finding a single nest, so cleverly are they hidden.

© Lee Passmore

THE TREASURE IS A TRAPDOOR SPIDER'S NEST

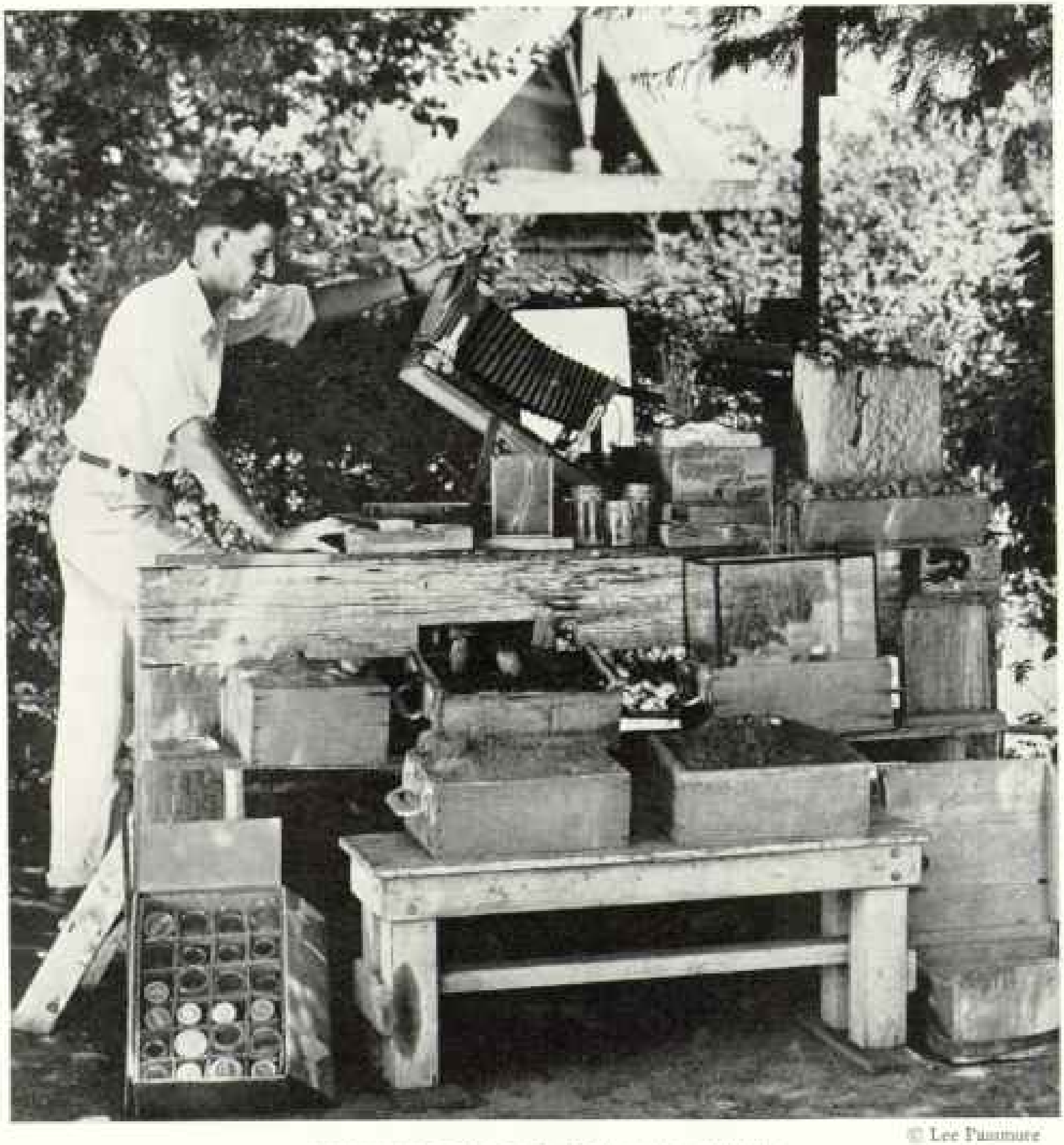
Francis E. Beck holds a nest which he has just removed from the gray adobe soil of the southern California foothills. Numerous little mounds scattered over an area of several miles formed an ideal location for the colonies of spiders. They seemed to know the protection afforded, for no water could stand on these knolls and the slope was just enough to drain without washouts.

Sixteen species of trapdoor spiders have been found by naturalists in the United States. Of these, eight are recorded exclusively from California. Others occur throughout the Southern and Southwestern States, with one species occurring as far north in Virginia as the Potomac (see Color Plate I).

Trapdoor spiders prefer high, dry ground for their nests; but even then they are not present unless conditions are favorable. They have been known to vanish from their natural habitat when virgin land is opened to farming. Probably plowing and cultivating destroy the nests and kill the spiders.

Some species of these spiders, which are almost identical with those that build doors to their nests, construct a home similar to that of their relatives, but with no trapdoor.

Mr. Beck found his first trapdoor spider accidentally in Balboa Park, San Diego. He was attracted to an object which resembled a silver half-dollar lying on the ground. Stooping to pick it up, he dis-



© Lee Passmore

A HOMEMADE ZOO FOR TRAPDOOR SPIDERS

The boxes contain "transplanted" or captive spiders living in their nests within blocks of adobe earth, dug from the field. Hundreds of sow bugs are caught and fed to the spiders by placing them on the ground near the trapdoors. The spiders crouch below, and when they feel or hear an insect approach they spring out and make a capture.

covered it was an abandoned door to a spider's nest. Beside it was a new door. Inserting his knife between the door and the inner side of the tubelike opening, he finally succeeded in lifting the lid and found the owner clinging to the under side.

The next time he went to the nest he was prepared to dig spider and home out of the ground. He trenched around the tube, keeping far enough away to avoid injuring it, until he could lift out the entire block of earth. After cutting away the outer covering of soil, he exposed a perfect web nest of the female spider. The lady had not been harmed in any way, and, "transplanted" to Mr. Beck's nursery, she became his first specimen.

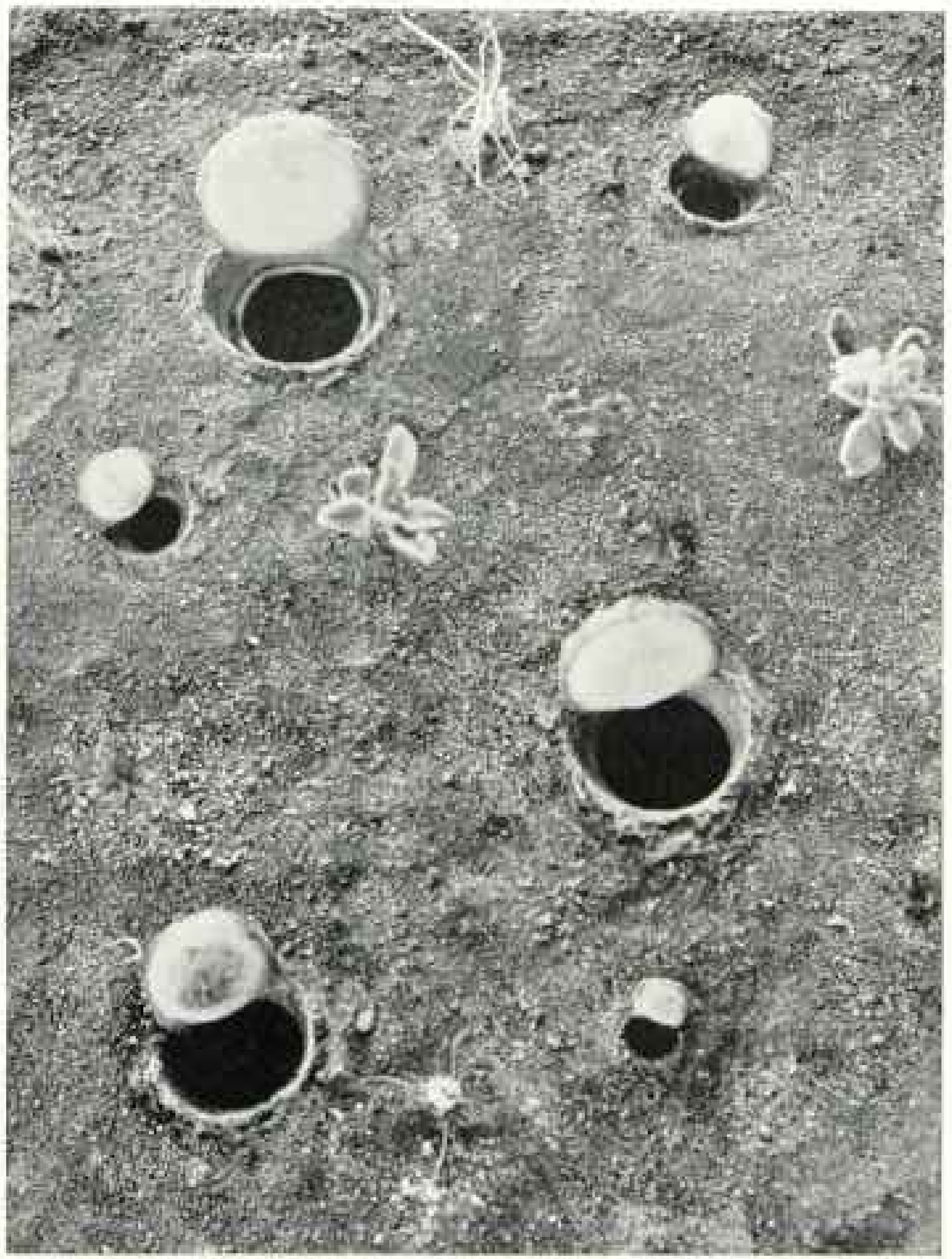
MALE PREFERS BACHELOR APARTMENTS

After the first year in captivity, she raised no young, although she deposited eggs regularly. These she devoured, for she apparently knew that they were infertile.

The male spider does not inhabit the same nest with the female, so we looked elsewhere for him.

A TRAPDOOR SPIDER COLONY WELL CAMOUFLAGED

The female spider deftly covers the top of her trapdoor with earth similar to the surrounding surface, to hide it from the view of unsuspecting sow bugs, grasshoppers, and other favorite insects. If the nest is located in mossy soil, the spider will stick the roots of living moss into the door as expertly as a true gardener. The nests vary in depth from two to nine inches, depending upon the age of the spider.



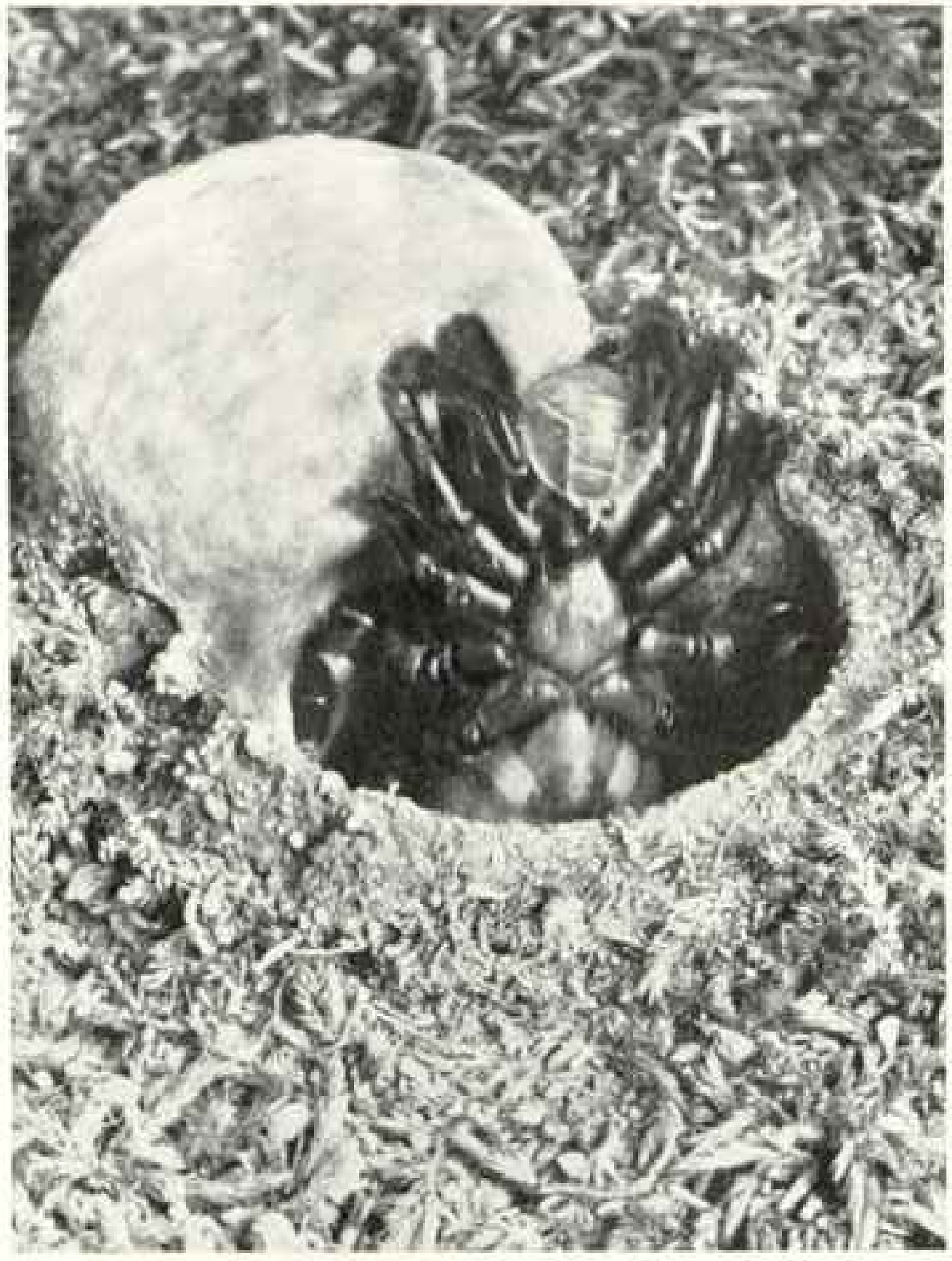
Photographs © Lee Passmore

THESE TRAPDOORS WERE OPENED BY HAND

Female spiders living as close together as this seldom see their next-door neighbors (see illustration opposite). They never voluntarily come out of their nests and crawl around the ground. When feeding at night, the door is open only for a fraction of a second while the spider makes a capture, but always part of the body is kept in the opening of the nest to prevent the trapdoor from snapping shut (see text, page 195).

A JACK-IN-THE-BOX SPIDER POUNCES ON HER PREY

The spider has just pushed back her cork-type lid and is about to sink her poison fangs into an unfortunate sow bug. The camera has caught the split-second action of a trapdoor spider feeding (see text, page 195, and illustration, opposite page).



Photographs © Lee Fassmore

SHE DROPS BACK INTO HER NEST WITH A VICTIM

Part of the captured sow bug protrudes above the spider. All eight of the appendages or legs radiating from the spider's cephalothorax and two of the breathing sacs on the abdomen are visible in this remarkable flash-light photograph.

© Lee Passmore

A SPIDER AMAZON GROWS A NEW LEG

Only the lower animals are capable of replacing lost limbs, and the trapdoor spider is one. Her new leg, second on the right side, is almost fully developed (see text, page 210).

Once when we were digging out a female nest we noticed a peculiar little heap of loose earth close to the door. Curious, we dug carefully around the burrow and, upon reaching a depth of three inches, we lifted out an entire tube. It proved to be a male trapdoor spider's nest, the first we had found in ten years' search (see page 203).

Except for an adult specimen presented to us by the O'Rourke Institute of San Diego, the little male is the only living male trapdoor spider we ever saw. We offer our observation here only as an opinion based on our discovery, and do not make a positive claim that all male spiders build nests.

At home, we laid our captive on some earth in a box and placed over him a small glass jar, covered with a black envelope to keep out the light.

The following morning we discovered our little male spider had burrowed. Above his tube was a heap of loose earth similar to that we had seen in the field.

Two months later we opened one side of his box and found the little fellow alive and extremely active, running up and down a burrow not more than a quarter of an inch wide and three inches deep.

It appears from our evidence that the male trapdoor spider builds a nest entirely different in its surface appearance from that of the female. This nest had no hinged door.

The female spiders seldom raise their doors in the daytime, unless the light is subdued or they are extremely hungry. We can occasionally tempt them out by imitating the tread of insects crawling near the nests, but they quickly detect the deceit and refuse to leap more than once or twice.

HOW A SPIDER BUILDS ITS TRAPDOOR NEST

In order to make a series of photographs showing how the trapdoor spider builds her nest and fits it with a water-tight, cork-type door, we filled a small box with adobe soil covered with growing moss, and put upon it, in an upright position, two inches of the door end of a spider's nest containing the female.

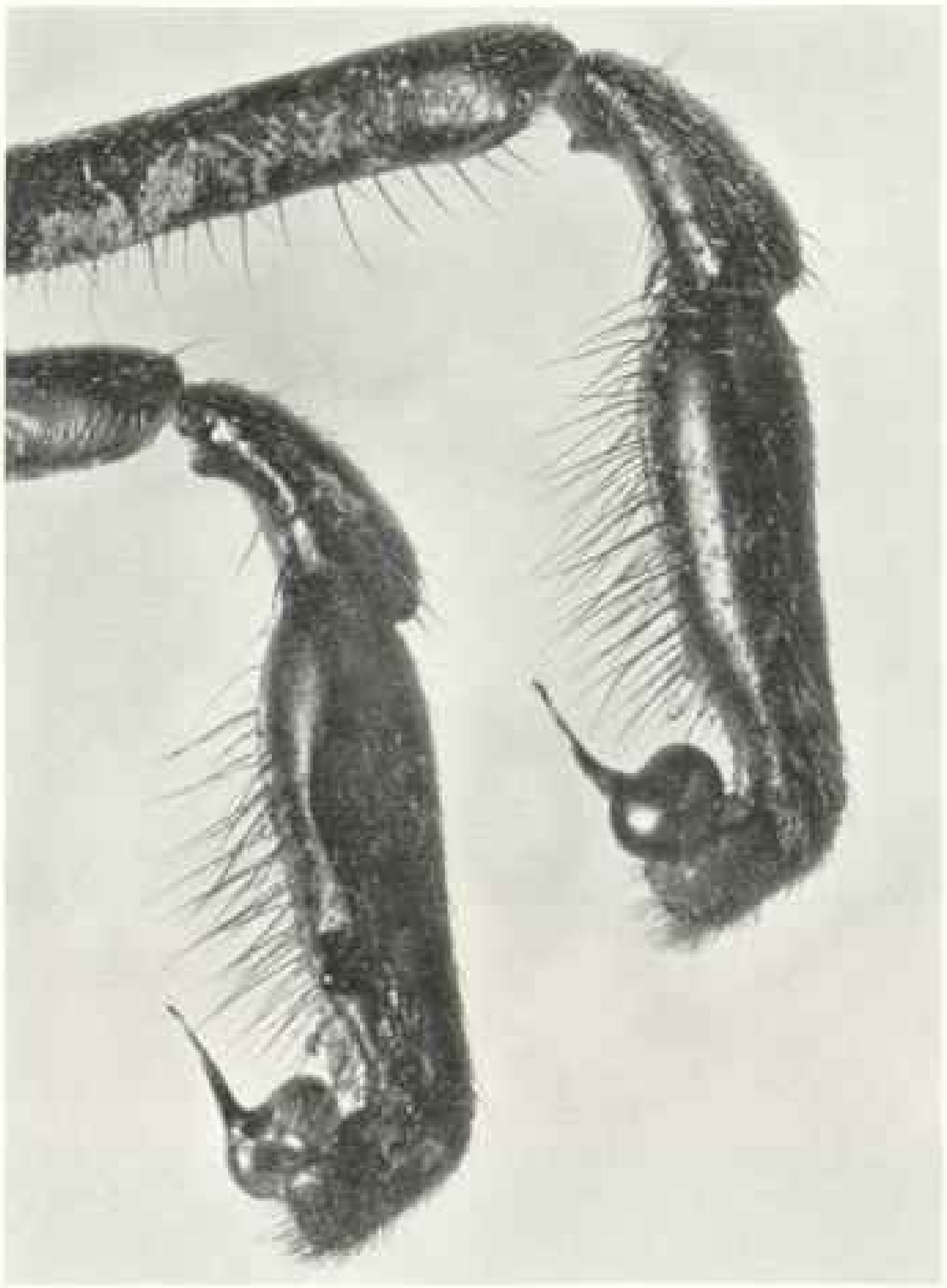
After several hours of patient waiting, the spider raised her door and brought some moss, which she dropped over the

side of the standing tube. She repeated this maneuver until all the moss had been cleared from the bottom of the tube.

Next, particles of earth were brought to the opening and flicked to a considerable distance with her feelers, or palpi. Upon lifting the door occasionally and peering into the tube, we could see her as she labored digging out the soil. Deeper and deeper she excavated, presently disappearing in the new burrow.

In the morning we removed the old nest and exposed the new one, but the spider by this time was down in the ground, entirely out of sight. To keep out the light during the day, we placed a tin box over this opening.

Soon after dark she again began to bring up more earth and make preparations to build a trapdoor to her new nest. She manipulated her sharp fangs as picks, smoothing the edges of the opening and trimming away all roughness. Then she brought damp soil from the bottom and applied it to the side of the entrance, packing it down solidly with her fangs and mandibles.



© Lee Pattinson

THE CLAWLIKE FEELERS OF THE MALE TRAPDOOR SPIDER

Only the first three joints of the feelers appear, greatly enlarged. When the eggs are fertilized, the bulblike organs with sharp claws lift the covers of the sacs, exposing the eggs, and permit the semen to enter.

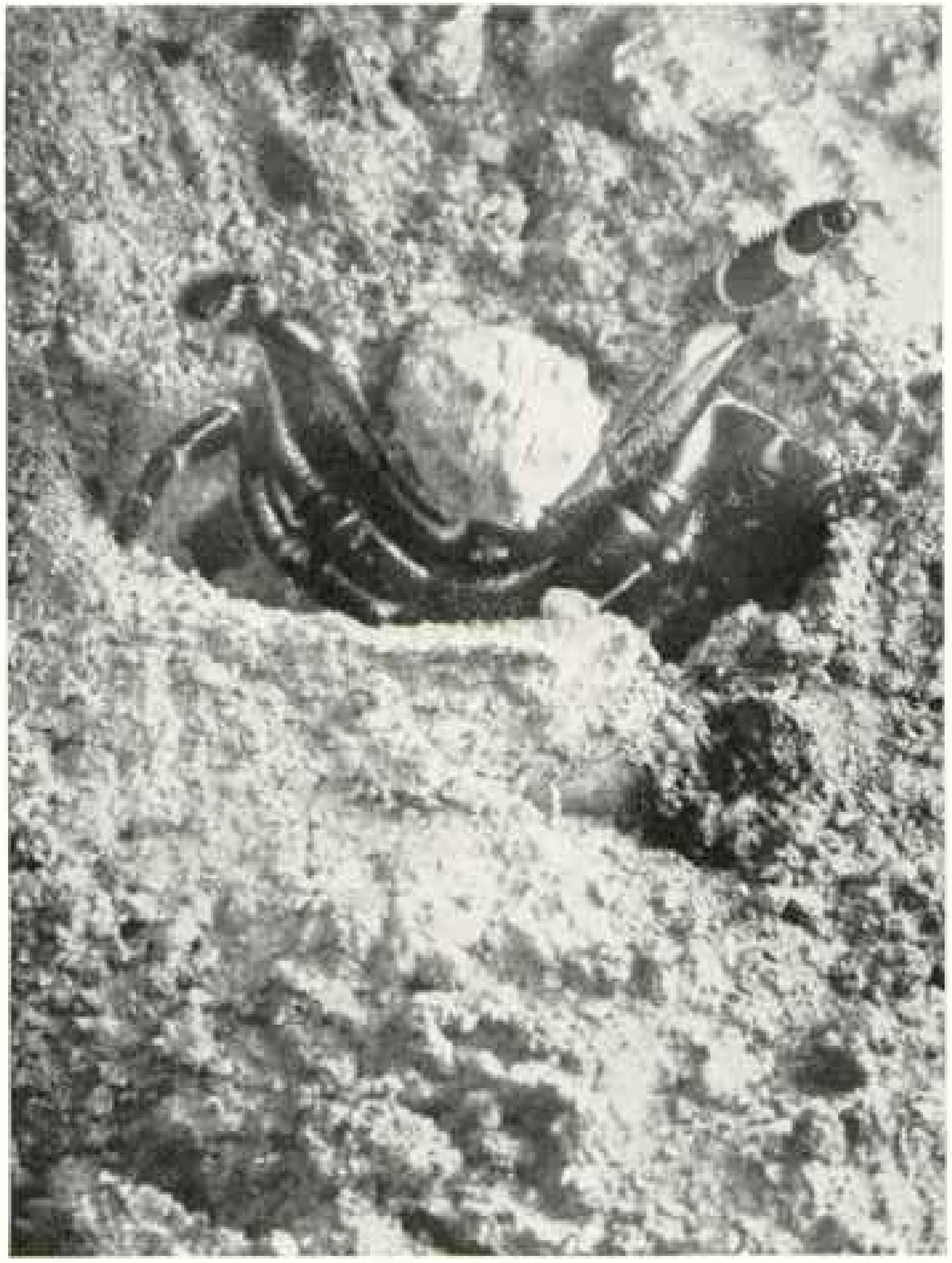
After adding fresh earth each time, she would turn around, bring her spinnerets into position, and with graceful movements weave a trail of silky webbing. She continued this process until the cover extended a third of the way across the opening (see page 209).

At this point we began to wonder how the little worker would manufacture a hinge for her front door, but she soon solved this problem in simple fashion. She raised the partly made door and bent it back to a vertical position. Naturally, it cracked in a straight line near the edge of the opening, but the flexible, reinforced webbing prevented separation from the side of the burrow. The fastening thus made was a hinge of amazing strength and durability.

WORKS WHILE HOLDING THE DOOR

Holding the door in a vertical position, she continued alternately to add earth and webbing to the outer edges until the door was completed.

Frequently during construction the spider would pull up tiny bunches of moss and plant it on the top of her door, carefully



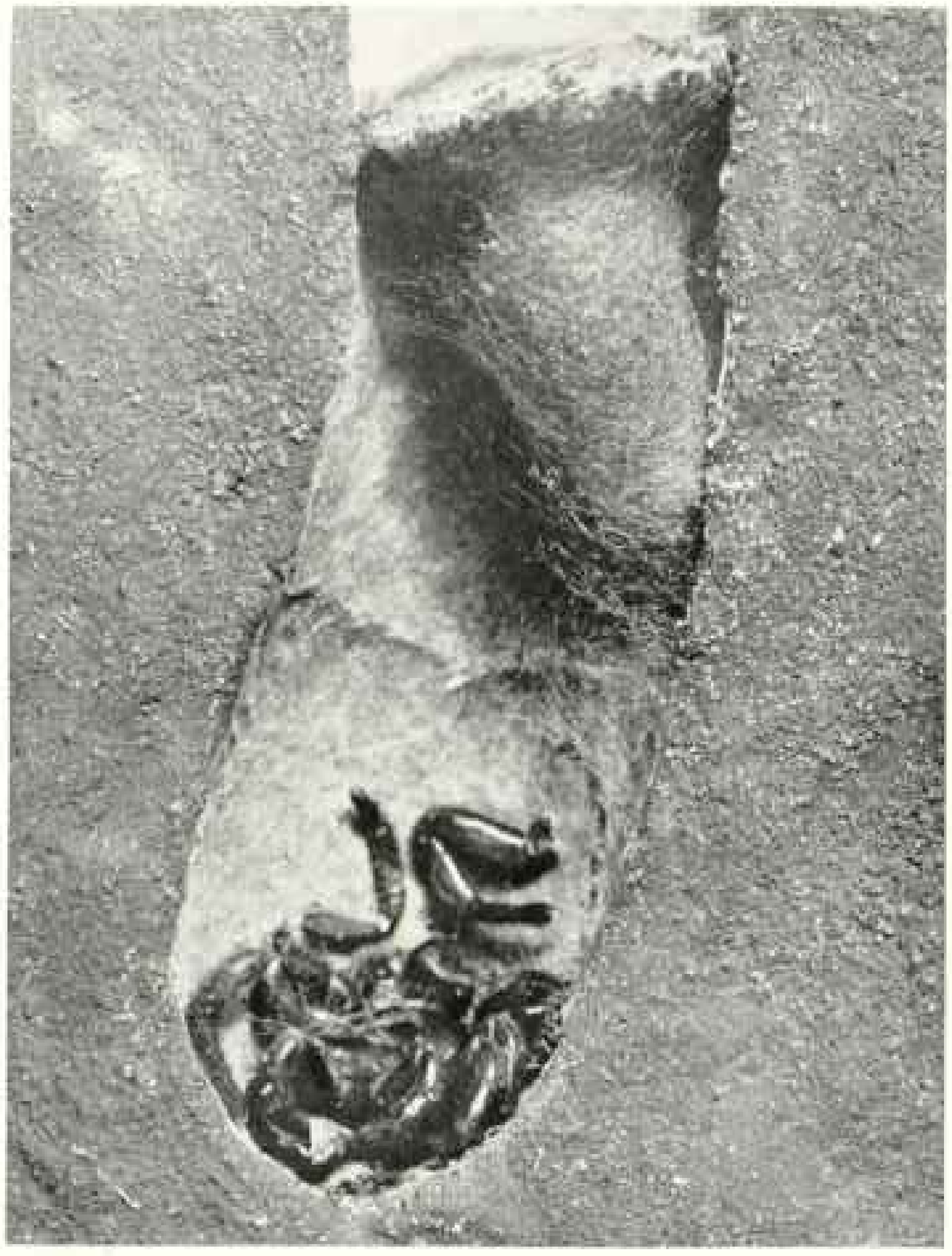
SHE HURLS A STONE HEAVIER THAN HER OWN WEIGHT

The spider shown in the photograph is bringing a large stone to the surface, holding it with her feelers. She seemed to have little difficulty.

Photographs © Lee Passmore

TRAGEDY ENTERS THE BURROWS

A trapdoor spider will never allow another to enter her nest, and when two meet while excavating they fight until death.



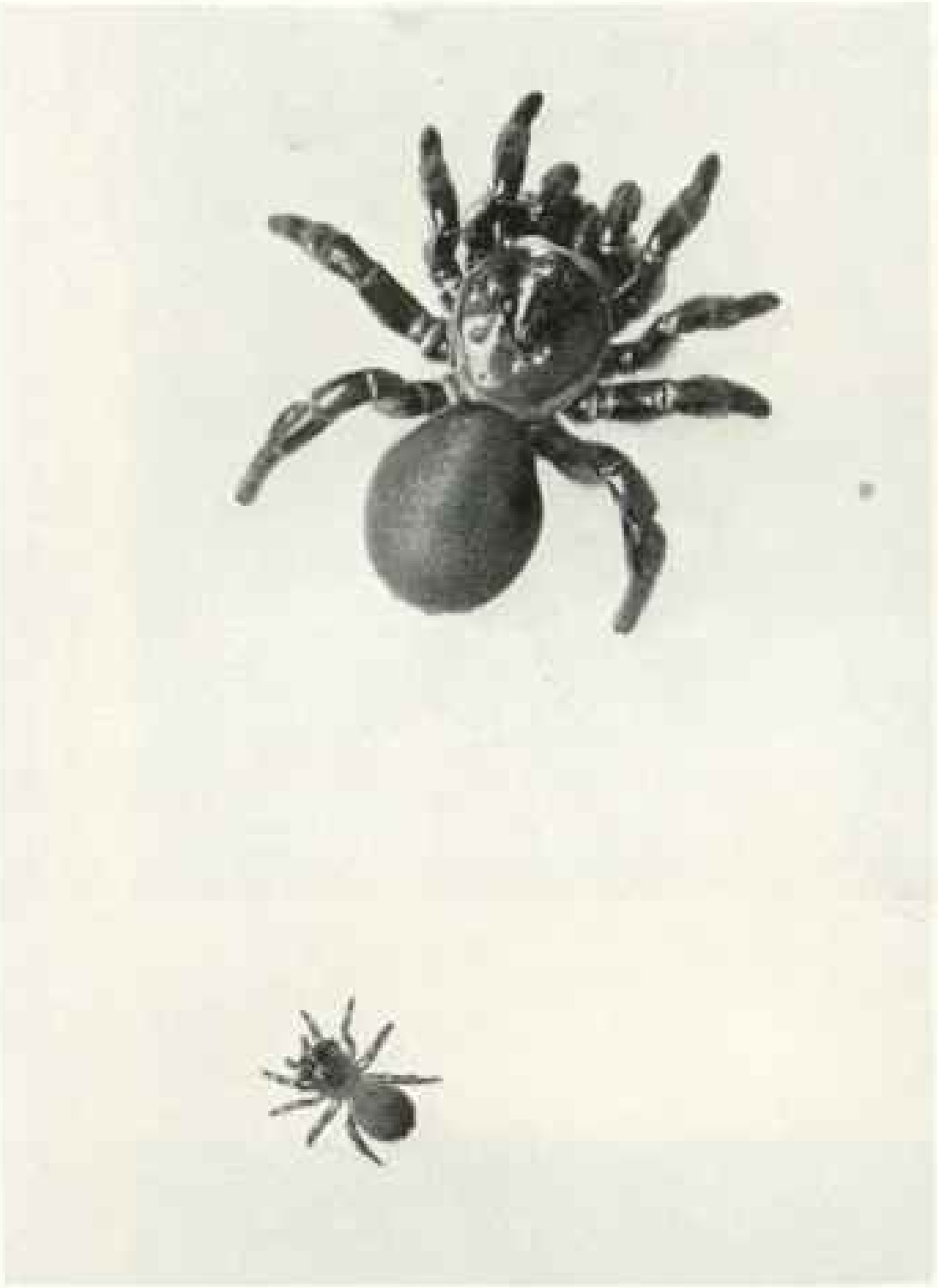
THE SPIDER BECOMES A VICTIM OF HER GUEST

The skeleton which lies at the bottom of the burrow is all that is left of the spider after a wasp larva has fed on its tissues (see illustration, page 211). The cocoon above was spun by the grub, which later will break its way out as a perfect spider wasp like its parent. Then, emerging from the burrow, the fledgling wasp flies away to look for a mate and another spider host to repeat the cycle.

Photograph © Lee Fassmore

A MALE TRAPDOOR SPIDER IN ITS PECULIAR BURROW

After years of search, this little fellow, uncovered accidentally, was the only male spider found by the author and his friend, Mr. F. E. Beck. They believe that the male builds a little heap of earth over his nest instead of the usual door. On three different occasions this male built a burrow exactly like the one in the photograph (see page 197). The male is considerably smaller than the female.



© Lee Paxmore

LIKE MOTHER, LIKE DAUGHTER

The small spider, about a year old, built a tiny nest only a few inches away from that of its parent and exactly like it in every detail. As she becomes larger, she will tear the walls away, enlarge the opening, and construct a new burrow. The figures are slightly enlarged.

sticking the roots into the earth as an expert gardener might do. To-day the moss is growing over the entire surface of the door and the nest is well camouflaged (see illustration, page 198).

While surfacing the under side of her door with webbing, the spider continued the process down into the tube and applied a fine silky lining to the walls of her nest. It was beautifully finished from the top to the bottom with a lustrous coating as smooth as paint.

Next, the spider pressed her two sharp fangs deep into the soft earth on the under side of the door near the outer edge. She did this several times, until she seemed satisfied with the holes, or "eyebolts."

Then, inserting her fangs again, she pulled the door shut in a succession of violent jerks. By degrees the door was drawn into the tube; and since both surfaces were soft and pliable, they soon fitted together as perfectly as a compression valve, making the nest watertight. This last operation completed the nest. The building had consumed about sixteen hours of actual working time.

Her work finished, the little creature closed her door and no doubt found a safe and comfortable place at the bottom of her new burrow where she could rest from her labors.

SEVENTEEN MONTHS WITH NO FOOD

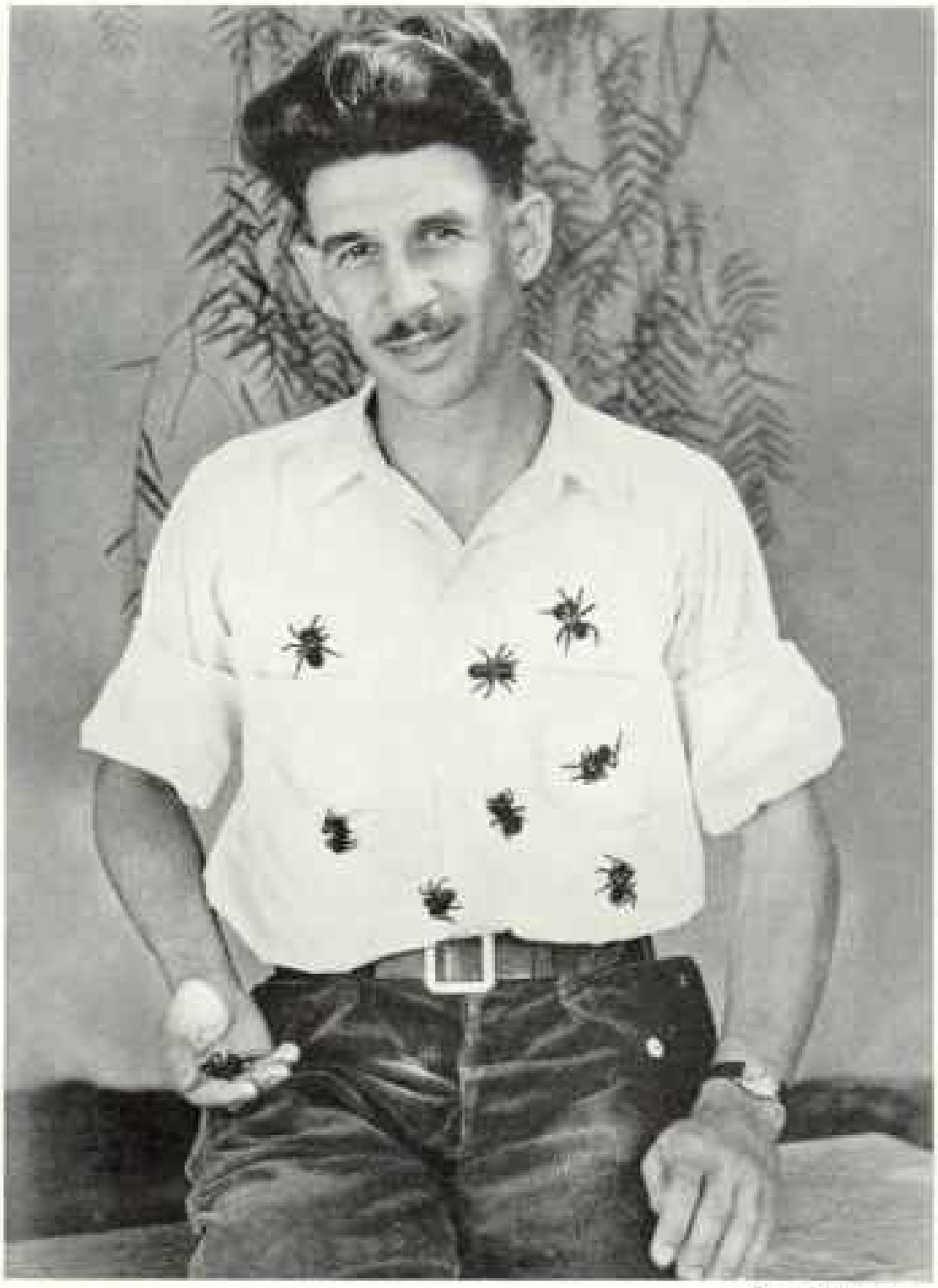
We tried to lift the door next day, but found the spider was on the job. She had a good grip on the lid with her fangs.

Later, we obtained a photograph of this spider capturing a sow bug, the first victim to be caught from the new nest (see illustration, page 199).

Trapdoor spiders sometimes hibernate, but at no given period or season, as does the true hibernating animal. We have found on numerous occasions the nests of the spiders tightly sealed with earth just below the doors. One specimen was kept under observation for more than 17 months, the spider living in self-imposed solitary confinement during that time, with no way of procuring food. At the end of her hibernation she removed the seal and appeared fresh and clean. She had shed her outer skin.

The mother spider seals the door also when she is about to lay her eggs, for she must not be disturbed at this time. Sometimes seals are made of thin web, stretched tightly across the opening.

This we thought at first was for the purpose of keeping the young spiders in the nest, but we had to abandon the theory when we found webless nests containing young spiders. The latter seem to enjoy the warmth of the sun, for often during the day they cluster around the opening just below the door and retreat to the bottom of the tube only when the surface of the earth becomes cooler with the approach of night.



© Lee Pattinson

TRAPDOOR SPIDERS ARE HIS HOBBY

For more than ten years the author and Mr. F. E. Beck, who allows his charges to crawl over him, have been gathering these peculiar spiders and studying their solitary habits. Trapdoor spiders still remain among the least-known creatures of the animal world.

THE VICTIM BECOMES THE KILLER

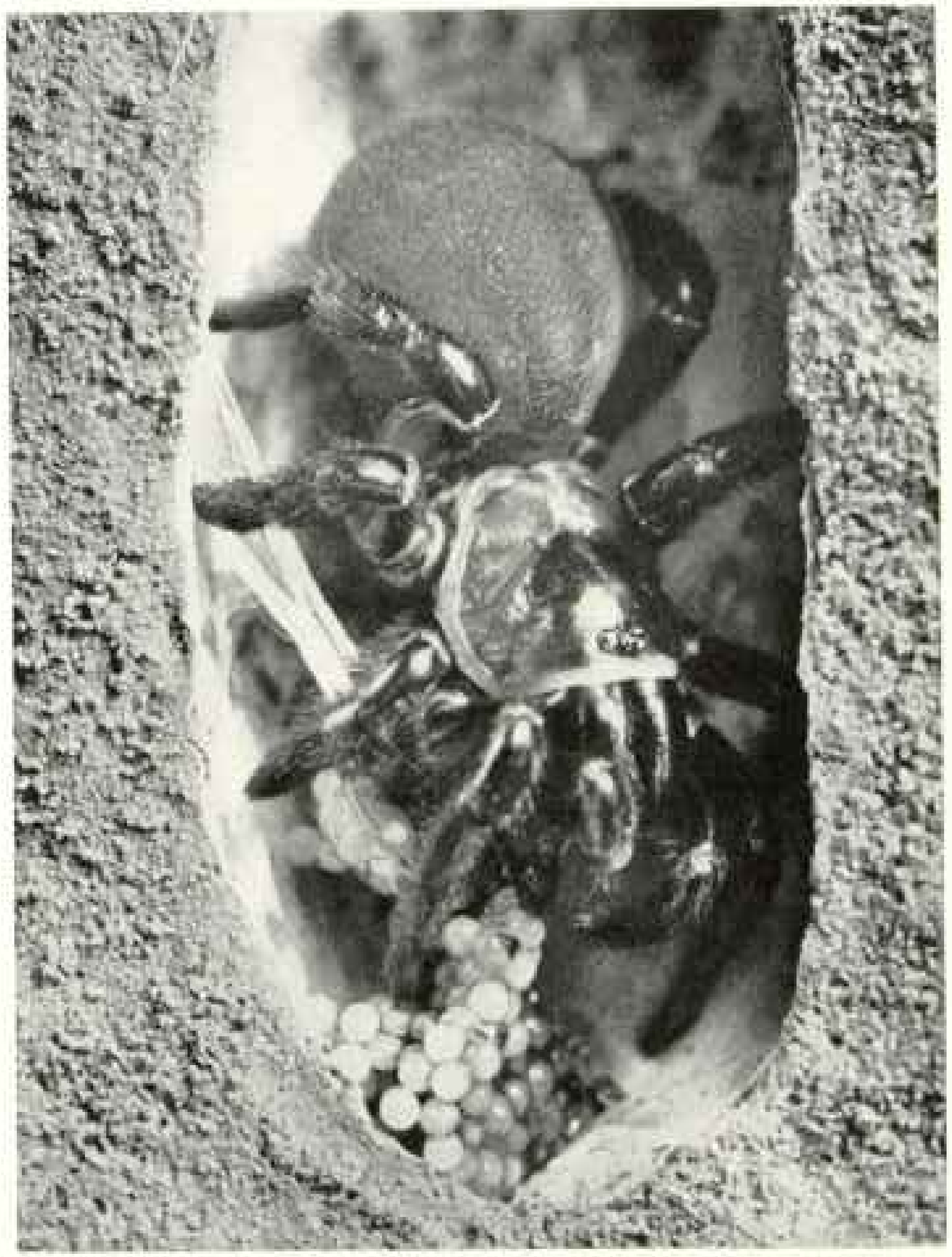
We have never found young spiders in the nests of females which have been held in captivity for more than one year. To the contrary, all nests brought from the hills unbroken and containing eggs produced the usual two or three hundred young spiders.

When extreme hunger causes the spider to capture her prey in the daytime (and this often occurs), she is attracted to her door by the vibration of any insect that walks over the ground near her nest. She may even mistake for the usual sow bug a spider wasp (*Pepsis mildei*), her most deadly enemy, which, alighting by her door, she recognizes too late (see page 211).

In the struggle the wasp stings and paralyzes the spider, rendering her entirely defenseless. The door to the nest being open, the wasp enters the burrow, dragging its helpless victim to the bottom, and deposits an egg in or on the living spider.

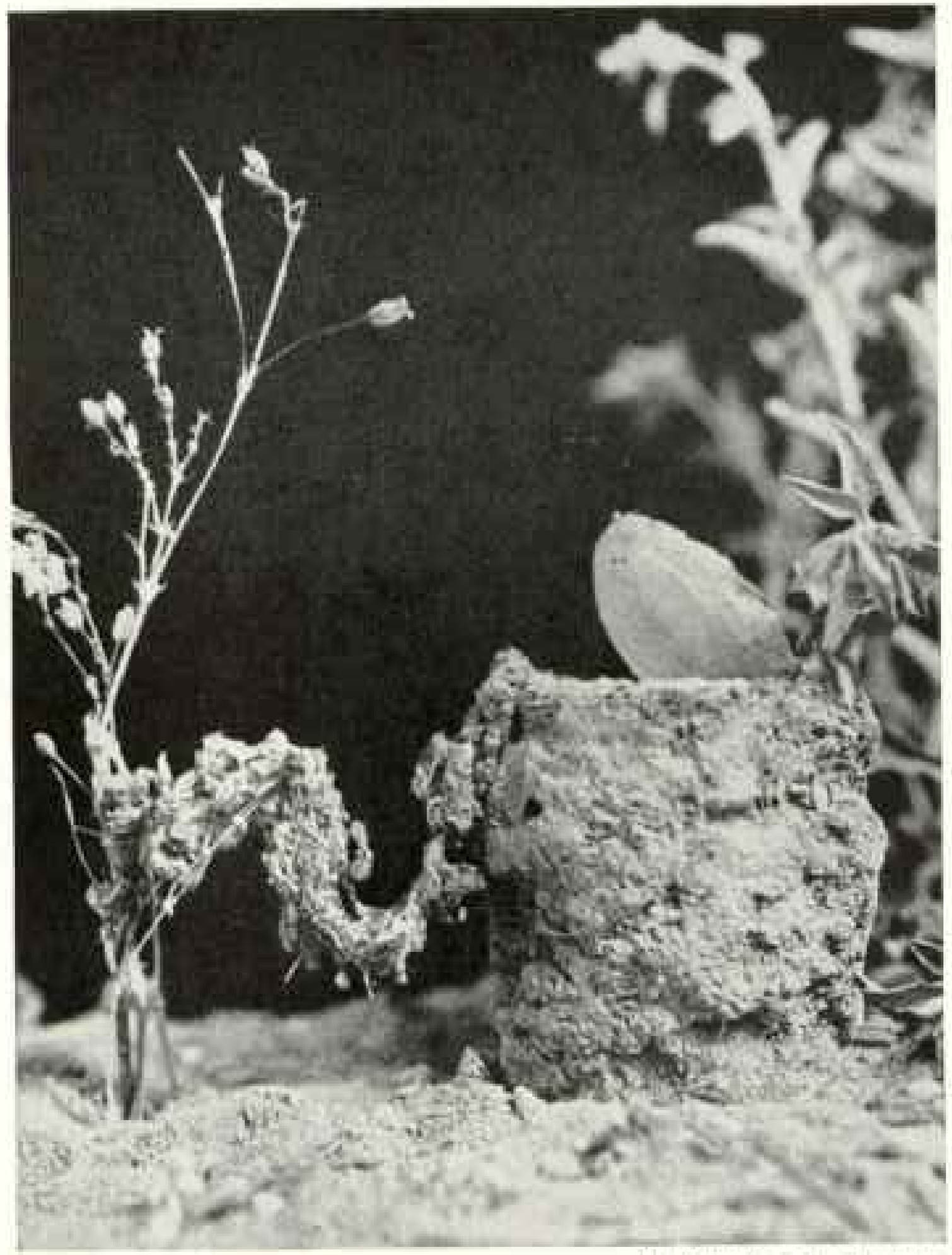
The grub, when hatched, burrows into the body of its host and feeds on its tissues, but does not attack such vital organs as the heart. The spider lives with the grub within it, usually until nearly time for the latter's pupation. The grub then spins a silken cocoon around itself. Later it breaks its way out and appears in the form of a perfect spider wasp, which after mating finds another spider host to repeat the cycle (see illustration, page 203).

When death comes to the owner of a nest, no other trapdoor spider will take possession.



SHE EATS HER OWN INFERTILE EGGS

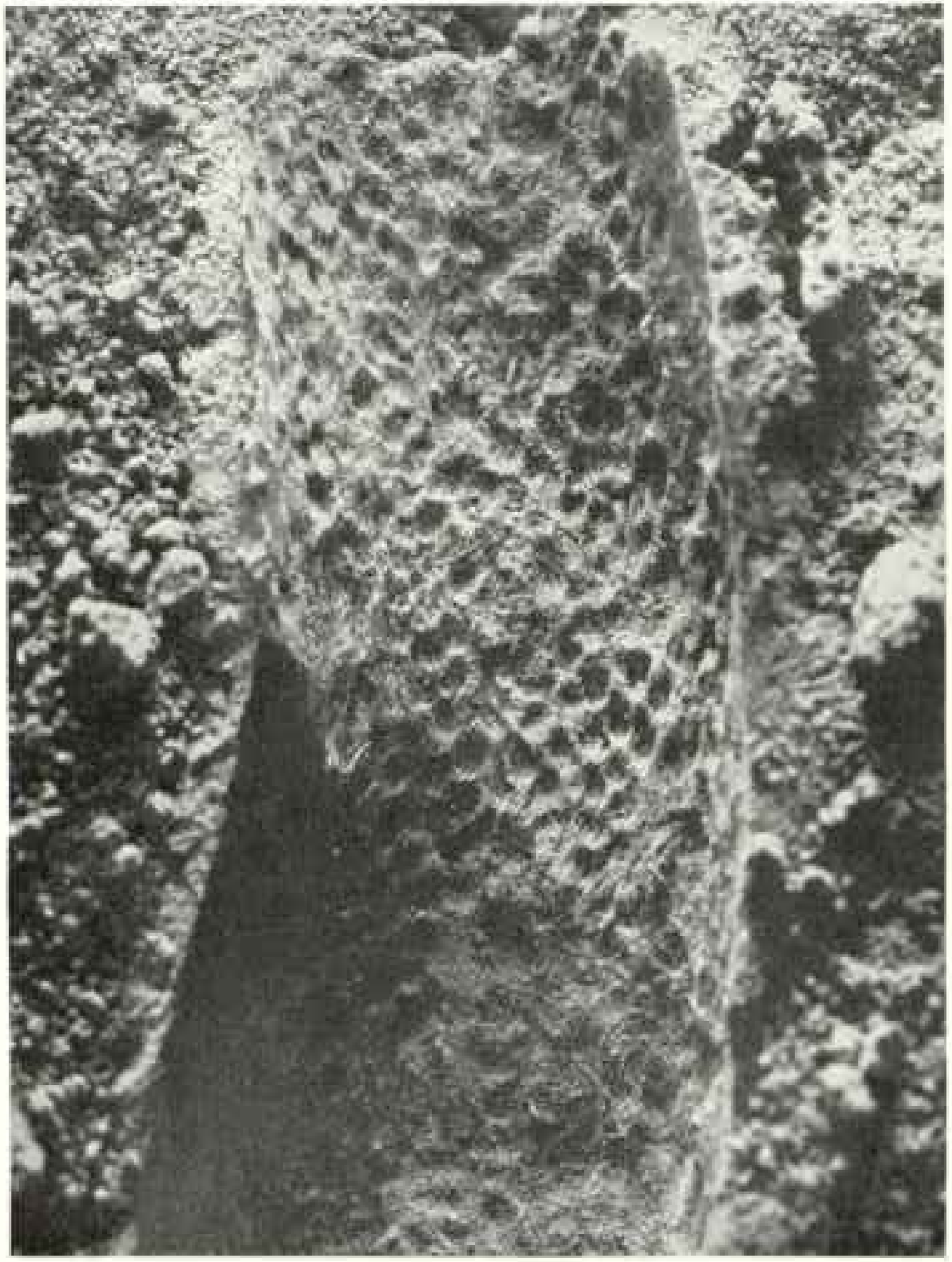
In a little more than an hour the spider devoured about 300 eggs. When she had finished her repast, the spider appeared no larger than she did before commencing, even though the egg mass was the size of her abdomen. About half of the uneaten eggs had fallen from the sac and lay at the bottom of the burrow when this photograph was made.



Photographs © Lee Passmore

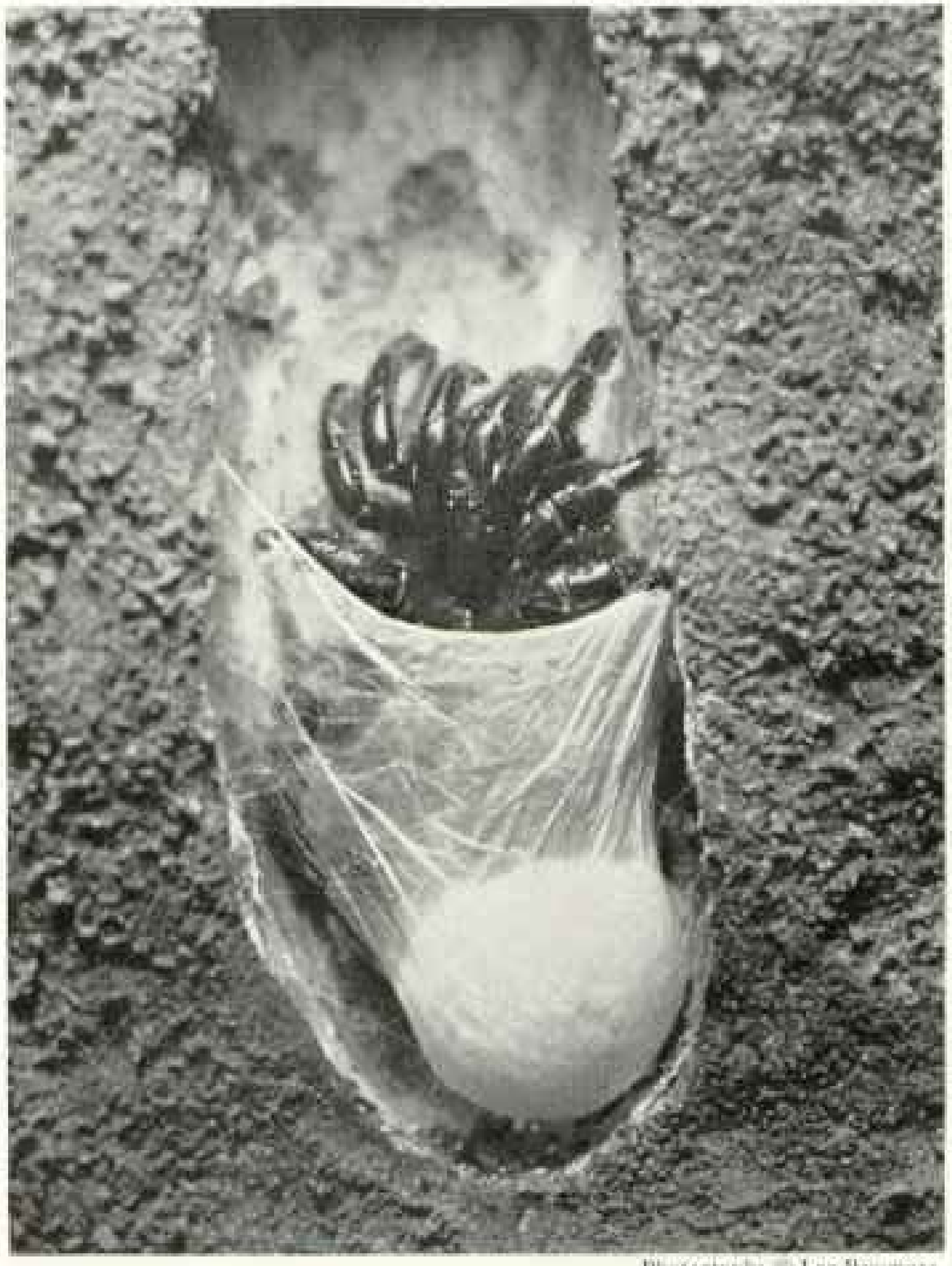
THE SPIDER USES WEBBING AS A CONVEYOR BELT

When the female spider is excavating, instead of carrying small bits of earth to the surface one at a time, she spins sticky webbing over the mass, making the earth cling to the web by stirring it about. Then she pulls the webbing to the surface as a sailor would pull a coil of rope from the hold of a ship.



INDENTATIONS MADE BY A SPIDER'S FANGS ARE HARD

After the spider has completed the excavation of her burrow, she invariably tamps the walls with her fangs, to keep the earth from crumbling in. Silk webbing is then applied as smooth as paint (see page 200).



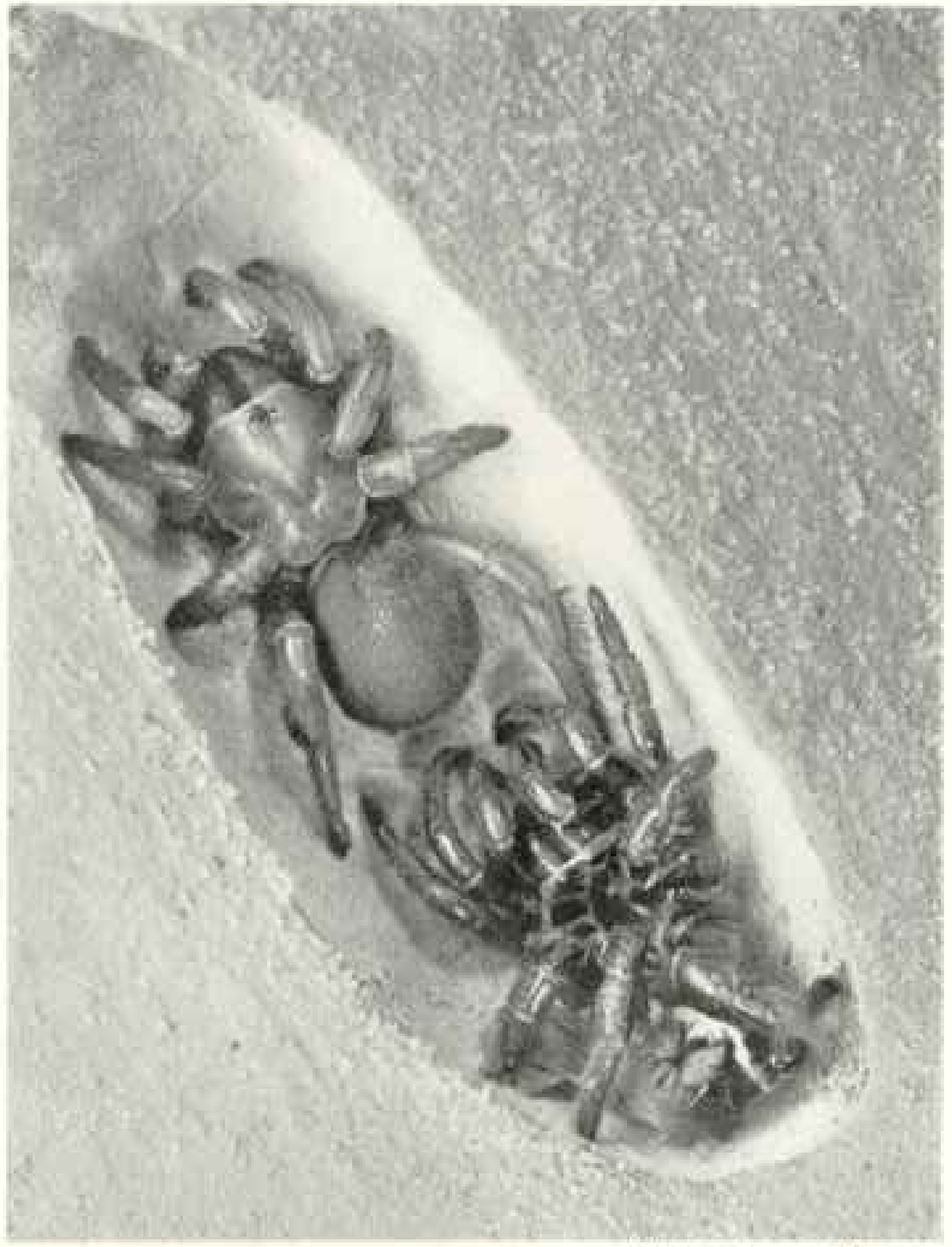
Photographs © Lee Passmore

THE MOTHER STAYS CLOSE TO HER EGGS

When the spiderlings are hatched and ready to leave the sac, the mother makes an opening through which they emerge, to swarm over her body and around the walls of the nest. The door is usually sealed during incubation.

A TRAPDOOR SPIDER LINES A JAR WITH A FILMY WEB

Placed in the jar on a dark shelf and forgotten, this lady spider tried to make a nest out of her temporary home. When found, the jar looked as if it contained milk, for web lining covered the walls but not the top.



Photographs © Leo Pasmore

NOT TWO SPIDERS—BUT ONE AND A DISCARDED SKIN

This spider, having shed only two days before, was too weak to move, and had to be lifted into the position shown in the photograph. Trapdoor spiders (see page 210) begin to shed when they are about two months old.

A SPIDER BUILDS A TRAPDOOR

Holding the door vertical and standing on her head, the spider has brought her spinnerets into position and is applying a spray of web over the edges and the under surface. Damp earth is used for reinforcing, especially in that part where the hinge is located (see page 201).

Photographs © Lee Pasmore

A PIN IS NOT ENOUGH WHEN SHE CLINGS WITH HER FANGS

Usually, when the door is shut, the spider gripe with her fangs the two small holes near the top of the lid and braces her legs against the walls of the nest. A knife blade bends when attempts are made to pry open the door (see page 210).

Spiders, like snakes, are the object of man's instinctive fear, and the first impulse of the average person upon encountering either is to destroy them. With few exceptions, however, spiders are harmless and will not bite if left undisturbed. The venom of a trapdoor spider acts very quickly on small insects, but it is not considered dangerous to a human.

Since they are all carnivorous creatures and maintain themselves by preying upon insects which are real pests, the spider is far more beneficial than harmful to man.

SPIDERS ARE HELPLESS WHEN THEY SHED

The most critical periods in the life of a trapdoor spider occur when it is shedding. The hard, non-living, shell-like outer skin, becoming too small for the growing spider, is cast off.

The trapdoor spiders usually shed in July, August, and September—that is, before the rainy season. In preparation for this period, they fortify their nests to guard against possible intrusion. Seals of well-packed earth placed just below the lid fill the entrance completely.

Once, when we were watching a transplanted spider building her new nest (see page 208), we noticed that she had stopped digging for no apparent reason. Upon investigating, we found our spider was shedding.

First, the shell-like upper surface of the cephalothorax, or anterior portion of the body, separated from the lower part and the skin covering the abdomen shriveled and peeled off. Then the body of the spider appeared, heaving and pulling as she endeavored to withdraw her tender limbs from their outgrown coverings.

It required more than an hour for the spider to separate herself from the cuticle, and she remained motionless for some time after emerging, completely overcome with the exertion. She seemed to have no control of her legs.

Standing beside her was the old casing, so little disturbed that it might easily have been mistaken for another spider. The betraying characteristic of the empty shell was the abdominal portion, which was not so prominent as that of the living spider.

The spider herself resembled an almost transparent wax model, reflecting light like a piece of glass. Even the fangs were white and the mandibles quite colorless. The only parts which showed any color were the eyes, the abdomen, and the coarse hair that sparsely covered her appendages.

Three hours later the spider became darker, first a pale blue and then a greenish blue. Within two days she was quite dark. On the third day she died, presumably from exposure to the open air and light.

Occasionally we uncovered evidence of the resourcefulness of the trapdoor spider in times of emergency, such as when her home is destroyed.

When a nest is built in soft gray adobe, the hot summer sun causes the earth to crack in deep crevices around it. A heavy rainfall fills these cracks and sometimes washes away the walls of the burrow. Soon the nest fills with the loosened soil and the once cozy home with silk-lined walls is ruined.

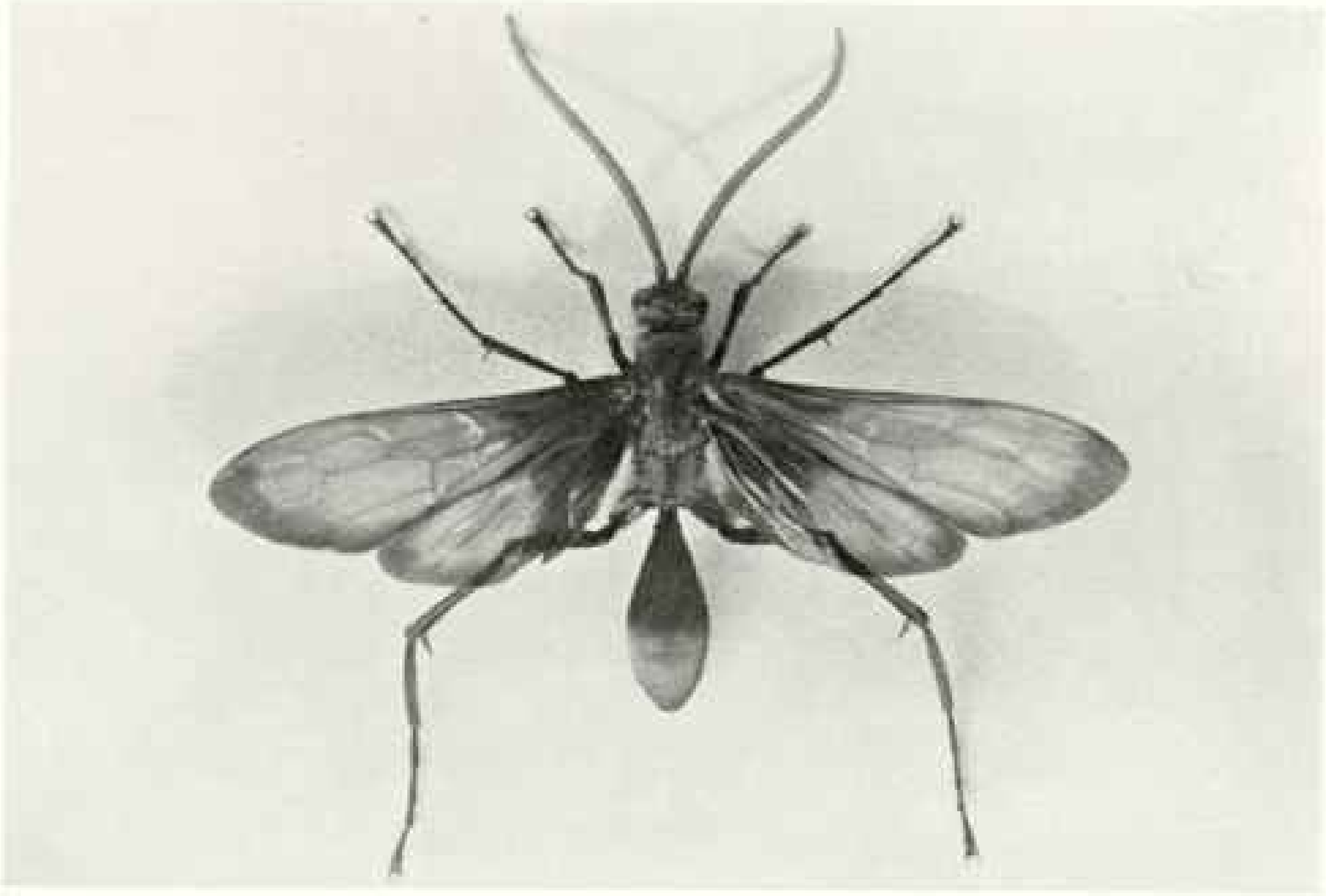
During the deluge the spider seeks shelter beneath her door, where she remains in safety until the storm is over.

If the door and beveled edges to the opening remain in good order, she rebuilds the damaged home alongside the original. It often happens that a spider completes her new nest just as another rainstorm comes, and she must go through the whole process again. We found one nest that had been rebuilt six times, the burrows being located side by side and all under the same trapdoor.

In contrast to her size and weight, the strength of the trapdoor spider is remarkable. She is capable of resisting a lift which we estimated at 10 pounds or more on her door. We came to this conclusion by the force we had to exert when prying upon the door with a strong knife blade. It would bend almost to the breaking point. Sometimes the web lining near the top of the burrow bears witness to her struggles to retain a hold, and the rims of the holes in the door are torn out by the pull of her fangs (see page 209).

SPIDERS MAY REPLACE LOST LIMBS

Only members of the lower orders of animals are able to reproduce lost limbs. The trapdoor spider has this peculiar power. However, we have found only one spider, among the thousands which have come under our observation, that bore evidence of having grown a new leg. This particular specimen was full-grown, and except for the dwarfed size of the second leg



© Lee Pantinore

THE SPIDER WASP IS A TREACHEROUS ENEMY

Sometimes the female spider captures its prey in the daytime and instead of a harmless sow bug finds herself in deadly combat with this wasp. Usually she is stung and paralyzed by the wasp, which then carries her down into the burrow. The wasp then lays an egg in or on the spider's body. Later the egg hatches into a grub, which burrows about in the spider and eventually destroys it (see text, page 205, and illustration, page 203).

on the right side, it was normal. The spider favored this smaller appendage as it walked. She would raise the small leg off the ground and carry it elevated, occasionally putting it down gently, as if it were causing her pain (see illustration, page 200).

How she lost her leg we do not know, but we believe perhaps a bird caught and tore it away from the body before the spider scuttled into the sanctuary of her burrow.

There is a remarkable difference between the palpi, or feelers, of the male and those of the female (see illustration, page 201). The female's feelers, long and strongly built, are used in building her nest. The male's feelers, however, play an important part when the eggs are fertilized.

The small, bulblike organ with a tiny claw extending from it serves to raise the cover of the reproductive organ of the female and expose the eggs for fertilization.

It is our belief that the male spider goes to the entrance of the female's home when mating occurs.

Our study of these solitary creatures continues, and we hope in time to solve many of the problems which as yet remain mysteries to us.

Notice of change of address of your NATIONAL GEOGRAPHIC MAGAZINE *should be received in the offices of the National Geographic Society by the first of the month to affect the following month's issue. For instance, if you desire the address changed for your October number, The Society should be notified of your new address not later than September first.*

A GOOSE GIRL OF THE BLACK FOREST

She wears a straw hat of a shape worn by her mother and her grandmother before her. Geese raising is as common a household practice in the Black Forest as chicken raising is on many small American farms.

FREIBURG—GATEWAY TO THE BLACK FOREST

By Alicia O'Reardon Overbeck

"YOU'LL like Freiburg." The learned professor beamed on me through thick glasses. "You Americans are young, but we Freiburgers are brittle with age, so old that we're proud of it. Freiburg is romance, a living story plucked from the past."

"You'll like Freiburg." The old Englishman—staccato, red-faced, military—taken off his guard by my admiration of his Scottie, addressed me. "Used to be a corking British colony here, but they've all had to go. I'm sticking, though, even with fourteen marks to the pound. No place like Freiburg. Jolly little town."

"You'll like Freiburg." The American boy sitting on the park bench beside me had recognized a compatriot. "I've been working at the medical school for a year now, and, say, you ought to see their equipment and their operating theaters and their X-ray laboratories! There's lots going on all the time for us students, too, and it's nice the way you can step right out the back door into the Black Forest. Freiburg's swell."

"You'll like Freiburg." The earnest agent with the shaved head who was helping me in my hunt for a furnished house glowed with civic pride. "Freiburg is so—so *gemütlich*" (homelike) (see page 246).

That was a year ago.

We found the furnished house, a delightful place, provided with porcelain stoves, feather beds, beehives, a vegetable garden, and that Schwarzwald (Black Forest) measure of opulence, a nice manure pile.

Though tucked in a nook of the forest, the house was, nevertheless, only twenty minutes' journey by tram from the center of town.

THE CELTS OF CÆSAR'S "COMMENTARIES"

We hired for $10 a month a cheerful peasant girl to do our housework, and dashed our protesting family into schools. Never, they assured us, had they heard of summer vacations starting in August and ending in September! And then we set about to discover in just what measure Freiburg is romantic, jolly, swell, and gemütlich.

The most carping spirit could not deny the romance that has its roots in an age long before Freiburg was dreamed of. Those same Celts that generations of boys and girls have encountered in Cæsar's "Commentaries" were the first-known inhabitants of the district. Although Celtic place names survive, these early settlers left few other signs of their existence. In the next village to us, however, parts of a Celtic wall and a moat constructed on lines described in the "Commentaries" remain.

Between the third and second centuries B. C. the Celts were gradually pushed out of the upper Rhine Valley by the German tribes.

FRONTIER COUNTRY FOR 2,000 YEARS

Then came the Romans. In B. C. 14 Tiberius crossed the Rhine, and shortly, what with the Roman legions on one side and the Germani on the other, the fertile plain known as Breisgau and the wild forest land called the Schwarzwald became what they still are, frontier country. In A. D. 74 a military road was built from what is now Strasbourg to the Danube.

Those were boom days, for under the protection of the Romans trade flowed up and down the road that ran along the right bank of the Rhine from Basel to Mainz, and in favorable places forts and small settlements sprang up. It was then that Badenweiler, slightly to the south of the present Freiburg, and Baden, to the north, first achieved renown as fashionable bathing resorts.

In about two hundred years the Roman bubble burst. The German tribes pounced down, took the forts, and again became masters of the Rhine.

By a curious turn of fortune in the seventh century, the Celts again appeared on the scene, this time in the form of Celtic Irish missionaries.

By the end of the eighth century the Germans were mostly Christianized.

By the beginning of the 12th century the Breisgau, of which Freiburg was the ancient capital, was a thriving district. Farmers tilled the heavy, fruitful soil of the flood plain, planted vineyards on the

THE HEART OF FREIBURG IS ITS CATHEDRAL AND MARKET

Since the 12th century farmers have brought their produce to the Münsterplatz, to the left of the Cathedral. There miracle and morality plays formerly were given on a stage close to the Cathedral porch, and there murder trials made holidays for the citizens. In this square the guilds assembled to defend the city when it was menaced by fire and invaders. From the portico of a house in the row facing the right side of the Cathedral many Hitler mass meetings were held preceding the recent elections.

warm south slopes, and trafficked with wandering peddlers from Strasbourg and Basel and even from Italian cities and the Baltic.

A HUNTING LODGE SUGGESTS A CITY SITE

Obviously the one thing needed to complete the picture was a center of trade, a city. And in 1120 Duke Konrad of Zähringen cast his eye about for a suitable site.

Just where the river Dreisam emerges from its valley and flows out into the Rhine Plain, on a well inclined flat of outwash gravel, stood a small hunting lodge. Here was the ideal city site.

Before it spread the fertile Rhine Plain; behind it ranged a semicircle of mountains split by the valley of the Dreisam. Here was ample water supply, sufficient slope to insure good drainage, and protection from inclement weather and foes. Most important of all, here was a junction of roads, the north-south road leading from Italy to the Baltic, and the east-west road leading from France to Swabia and the Danube country. The new town, then, would be a crossroads affair, through which travelers from every direction would have to pass.

With the hunting lodge as a central point, the Duke carefully planned the city of

Photograph by E. Baumgartner

THE GATE TO SWABIA COULD RECITE MUCH OF CENTRAL EUROPE'S HISTORY

Through the Schwabentor run the medieval road from the Gallic lands to the Danube country. Beside it stands the venerable Stork Inn and through its portals is the ancient Bear Inn (see page 231). In the background rises the airy grace of the Cathedral spire. The wall painting of St. George and the Dragon is a decoration of the present century.

THE BLACK FOREST IS GERMANY'S STATE OF MAINE

Formerly huge log rafts were floated down rivers to the Rhine; many went to the Netherlands. Logging still is a major industry and sawmills operate locally. The area has the equivalent of the American loggers' hero, Paul Bunyan, in tall tales that are told of Holländermichel.

Photograph by Emil P. Albrecht

WHEN CORTEZ WAS CONQUERING MEXICO THIS MERCHANTS' HALL WAS IN USE

To its intricate but harmonious design is added the allure of bright red and glittering gold. For more than 400 years it has served as the fiscal office of the market. Protruding on the right is the 17th-century Renaissance porch of the Cathedral, the only important addition since the dedication in 1513.

Freiburg. Four principal gates gave entrance to the town. Two principal streets crossed the hut at right angles and formed four large blocks, which were cut up into smaller blocks by narrow alleys running parallel to the main streets.

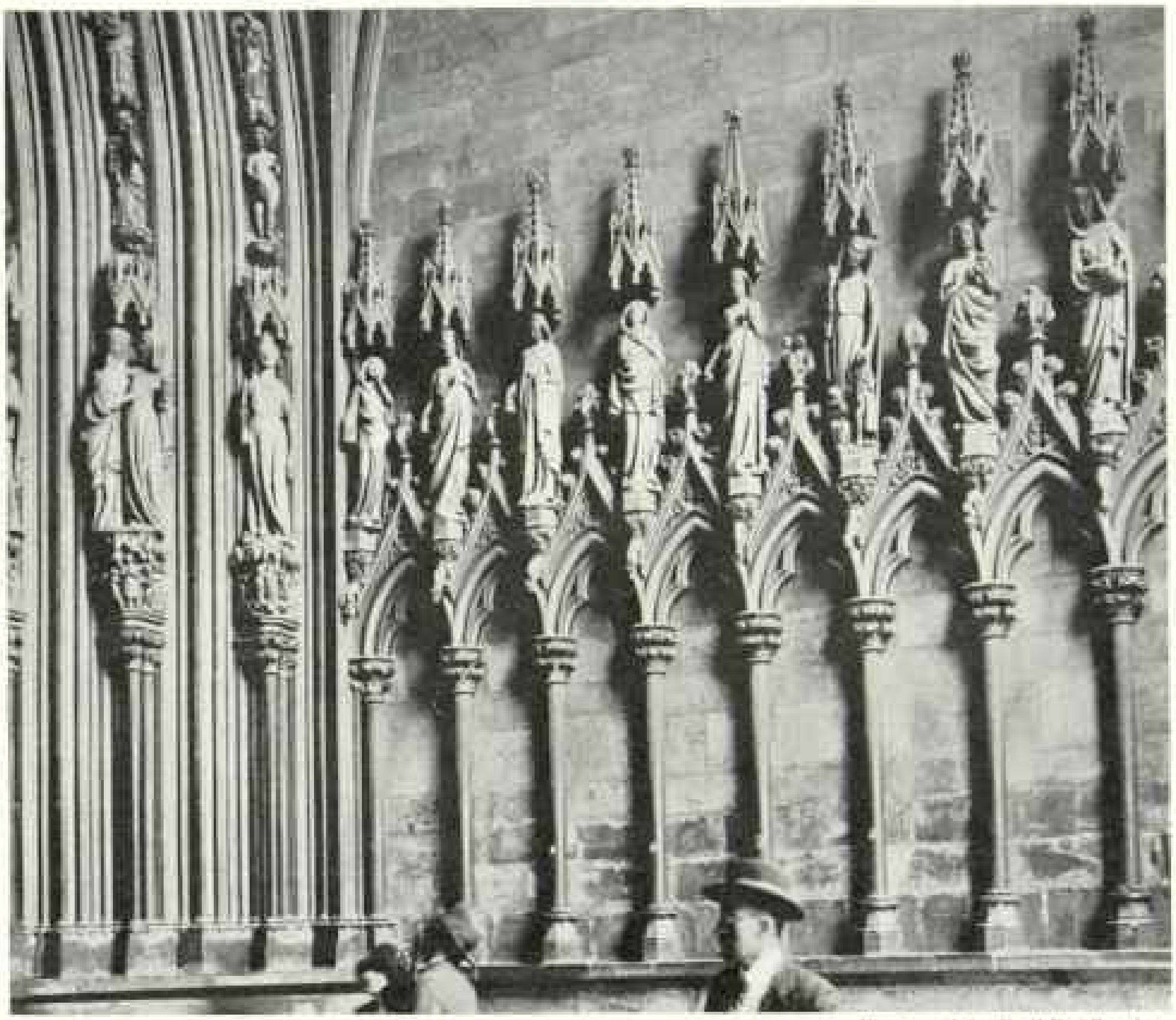
Giving play to his imagination, the Duke devised a scheme entirely new to medieval city planning, which caused a flutter among travelers of the day, whereby a series of swift-flowing brooks, supplied with water from the Dreisam, were directed down all the streets and alleys (see pp. 220, 236).

These brooks carried away the sewage and insured a supply of fresh water, giving to Freiburg a reputation, which it has never lost, for cleanliness and healthfulness. They took the place of washtubs and they acted as first aid to the fire department.

So ingenious was their arrangement that when smoke came curling from some thatched roof, when flames licked about some flimsy wooden dwelling, when watchmen shouting "Feurio, feurio!" ran through the town, all the water could be concentrated in the street of the disaster. Thus, when the Guild boys, waving banners and armed with leather buckets, reached the scene a fine lake was ready for them.

CITY'S "FORTY-SECOND AND BROADWAY" DATES FROM 1120

Since a town is not a town without inhabitants, the versatile Duke worked out a plan to boost population. He named his offspring Freiburg and promised freedom to any man who would live within its walls for a year and a day. Such intoxicating



Photograph by Emil P. Allaschi

SEVEN FOOLISH VIRGINS—AND SOME EXTRAS

The decorations on the south side of the Cathedral porch are in contrast to the Seven Wise Virgins on the north side. Architectural balance demanded some additional figures. In the Middle Ages the Market Court sat on the red sandstone benches beneath these decorations. To-day weary market women and giggling country girls seek shade and rest on the same benches.

liberty naturally drew people from far and near, and within a hundred years of its founding Freiburg was one of the most important cities of the upper Rhine.

It is astonishing how many of the characteristics of that Freiburg of the 12th century survive to-day. The walls are gone, save for scattered remains here and there. Two of the gates have vanished, leaving only the highly decorated and impressive tower gates, Martinstor and Schwabentor; but the spot where the hunting lodge stood is still the center of the city, and the principal streets of 1120 which intersect this spot are still the principal streets in 1933.

Freiburg streets have lost little of their medieval savor. Within the limits of the original wall, the streets and alleys, some so narrow that only a German rarity, two thin people, can pass in them, twist and bulge and bend with startling abandon and a rakish disregard for right angles.

Many of them, too, still bear their quaint old names. Oberlinden Square, where a linden tree has stood, according to definite official record, since the middle of the 12th century, has been known by the same name since the city was founded.

STREET NAMES TELL A STORY

The Salz Street was the old salt market. The Beautiful Corner, Convent Street, Shoemaker Street, Butter Alley, Grapevine Alley, Orphan House Alley, Angel Alley, and The Presence Alley tell their own stories.

The brooks also remain. A few, especially in the main streets, have been covered

ON MARKET DAYS CATHEDRAL PLACE RESEMBLES AN ORIENTAL BAZAAR

Peasants in the dozen or more distinctive costumes of the Black Forest, housewives driving thrifty bargains, and a sprinkling of visitors crowd the spacious square. In the Cathedral porch (left) flower sellers seek the shade, against the buttresses butchers set up their stalls, and in the lovely Renaissance south porch market folk stow empty baskets and pushcarts. On the Schlossberg, in the background, stood the famous castle of the Counts of Zähringen (see text, page 214).

A STRANGE SYMBOL OF PIETY

On Corpus Christi the women of Eschbach wear these top-heavy headdresses, made of white flowers, and the long streamers of white ribbon embossed with red figures.

SCHOOL IS OUT!

Their daily session begins earlier and the school year lasts much longer than those of American pupils (see text, page 239). Black Forest children wear their book bags strapped to their backs.

Photograph by E. Baumgartner

CLEAR WATER FLOWS THROUGH MANY STREETS

These channeled brooks were a part of the original city plan, which, in the 12th century, anticipated a delightful feature of Salt Lake City, Utah. Small boys wade and sail boats in them.

with gratings, and only the broken purl of water tells of their existence. But in most of the lesser streets they hurtle along, open and clean and sparkling, exquisite expanses for small boys to sail boats, delicious places for youthful paddling when the hot days come.

Not a few of the houses that flank these narrow, twisted streets date back to the city's infancy. For Freiburg, unlike most of the towns of this frontier country, such as Heidelberg, was never entirely razed by enemy fire, although it has belonged in turn to the Zähringens, to Austria, Sweden, France, Italy, and Germany. It has withstood almost countless sieges and has had its suburbs burned to its very walls many times.

It is not uncommon to see buildings with 13th- or 14th-century date plates. Some of them still bear the names which were in use long before street numbers had been thought of. The Black Letter, the Golden Tankard, and the White Goose are among these; but my favorite is the House of Old Simon (1460).

"WHEN KNIGHTS WERE BOLD"

One morning during preparation of this article, as I scurried through Shoemaker Street on my way to market, I noticed a modest gray house which had inscribed on its protruding, water-on-the-brain brow not only its name and date (1381), but the names of its various owners. Freiburg real estate is apparently not active.

The odd thing about many of these old places, however, is that you must really know Freiburg before you discover them. Stand at the fountain on the reputed site of the hunting lodge, for instance, and cast your eye up and down the intersecting streets on a level with the pavement. You see windows full of furniture, or sausages, or hats, or flowers, or rows of those extraordinary wax figures whose marked family resemblance and abandoned poses are peculiar to Germany.

But raise your eyes above the shop windows and you are back in the days of old when knights were bold. No two houses are the same height or width or color; no two roofs are the same shape or tilt. Step gables mount dizzily, high-peaked roofs lurch skyward, dormer windows stand out like staring, inquisitive eyes.

Faded religious pictures—the Holy Family, the Bleeding Heart, the Annunciation—decorate the bent or bulged fronts of the buildings. Beautifully carved and colored coats of arms surmount deep, wide doorways, and in niches in the walls are painted and gilded statues of the Virgin or the saints.

The Breisgau has remained essentially Roman Catholic, and to the Roman Church Freiburg im Breisgau owes some of its most lovely monuments.

Freiburg's Cathedral was the first Gothic church of any size to be fully completed in Germany during the Middle Ages. It stands a little askew, like everything else in the town, in the wide Münsterplatz, or Cathedral Square. The enormous mass, of native red sandstone surmounted by a single soaring spire of almost incredibly delicate filigree work, was started soon after the founding of the city and was more than 300 years in building (see illustration, page 214).

WAYSIDE SHRINES OFTEN WARRANT STUDY

Every few hundred yards along the roads near Black Forest villages will be found wayside crosses. They range from simple figures to highly complicated displays.

Architects, painters, woodcarvers, sculptors, and masons came from every part of Europe to contribute to its beauty; and the long, low-roofed, heavily beamed dwelling that housed the architects and master builders during its construction still remains. One of the altar pieces was painted by Hans Holbein the Younger.

Naturally, over the three centuries of construction, plans had often to be changed, with a resulting mélange of styles: Late Romanesque for the transept and its two small towers (known as the cock towers because of the leaden cocks that top them), Early Gothic for the nave, High Gothic for the spire, and Late Gothic for the choir.

The whole, however, is singularly harmonious and inspiring.

When, in 1513, the Cathedral was finished it was dedicated with magnificence and ceremony in the presence of Emperor Maximilian I, and, with the exception of the Renaissance south porch, added in 1620, it stood then essentially as it stands to-day.

BELLS, BELLS, BELLS

The Cathedral bells are almost as important a part of Freiburg life as the Cathedral itself. Hosanna, familiarly called Susanna, is the oldest known Ave bell and was cast in 1258. Back in the dim past, when enemies had a way of suddenly appearing at the city gates, Susanna always sounded the tocsin; now she rings only on very special occasions.

The Silver Bell, smallest of the bells, still jangles out its thin silvery peal at 8 o'clock, a quarter-of-an-hour peal intended as a guide to travelers who, after darkness fell, were trying to locate the city.

Christ booms out the hours, Maria tells the quarters, Konrad, Michael, and the Protecting Angel are the little vesper bells. Peter at 9 o'clock warns householders to look to fires and lights, Paul at 10 announces bedtime, Alexander and Lambert ring the Salve and the Vigil, and John tolls Freiburg's farewell to its dead.

Besides the Cathedral, Freiburg has many other churchly remains; and I never cease to wonder at the enormous proportion of space occupied in the limited area of the old walled city by church properties. Twenty cloisters were recorded at the beginning of the 16th century, and some are still standing. The Augustine (now the City Museum) was probably Freiburg's oldest monastery, and a 14th-century picture shows that its original plan has scarcely been changed during the ages.

Across the street and close to the historic linden tree (see text, page 217) is the building that was St. Anthony's Cloister.

Five minutes' walk down the street brings one to the enormous group of buildings put up by the Jesuits in 1576. These were taken over by the University in 1773, when the Jesuits were expelled from Freiburg, and were used as a prison for British officers during the World War. Now they are again a part of the University.

Not half a block farther on is the Peterhof, a rambling, stoop-shouldered place with a crooked bay and high pitched roofs, erected by the friars of St. Peter in 1586. Only a stone's throw away is the Holy Ghost Hospital, which was officially complimented upon its good wine in the middle of the 13th century.

A few paces down the alley that runs along the east wall of the Jesuit Monastery is the Church of St. Martin and the Barefoot Cloister. The gray Basilica, with its facings of bright red, was put up by the Franciscan friars at the end of the 15th century, but even before that the cloisters were there.

In front of the Barefoot Cloister, atop a stone fountain, is a statue of a tonsured, brown-habited, barefooted monk. This is one of Freiburg's distinguished citizens, Konstantin Anklitzen, in religion Brother Berthold (see page 248).

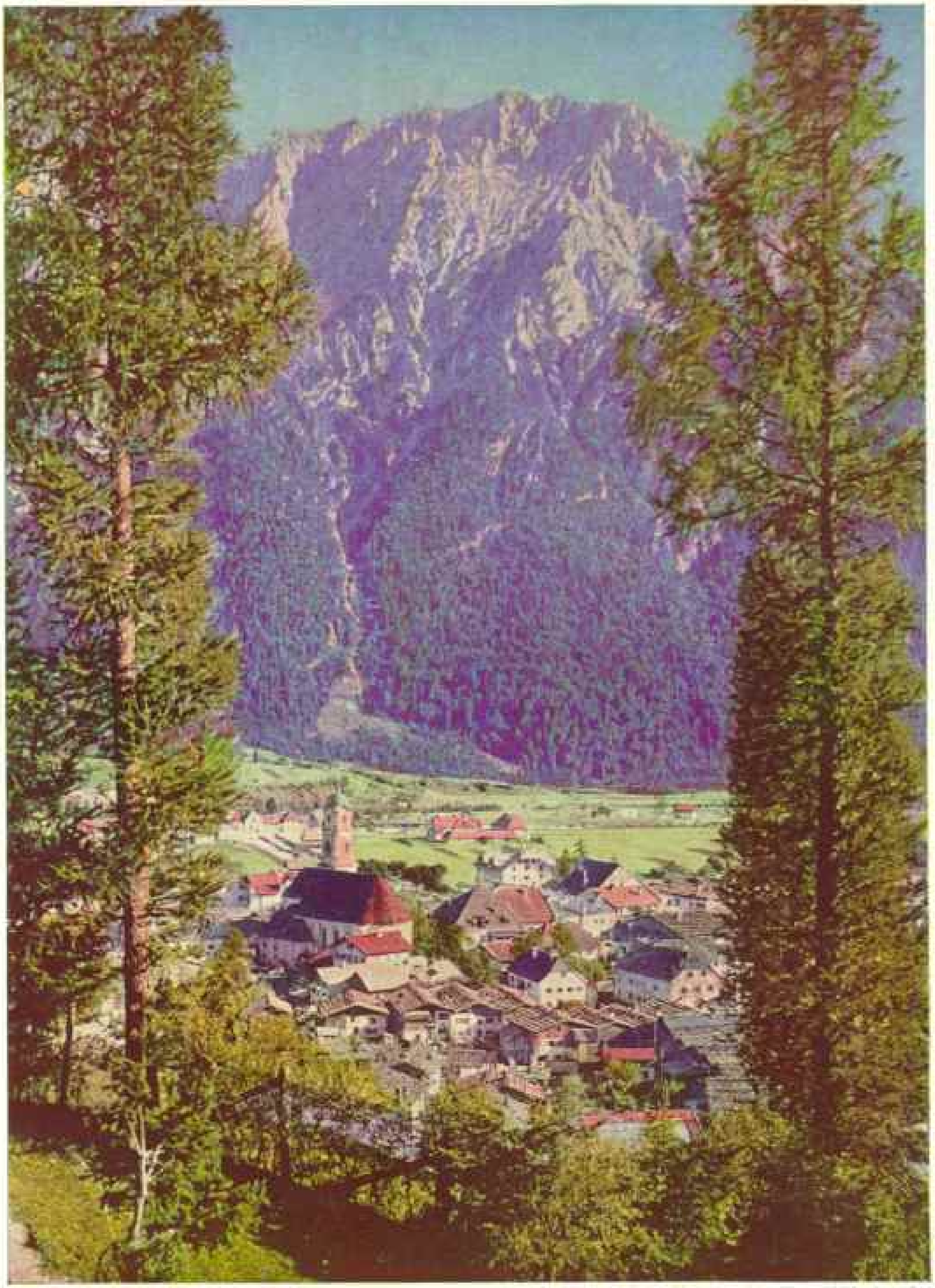
THE HOME OF GUNPOWDER AND THE CANNON

Dubbed Schwarz (Black) because of his uncanny skill in alchemy, Berthold, while on a still hunt for the Philosopher's Stone, accidentally hit upon gunpowder. His discovery was looked on with little favor by his colleagues, who, although they found the powder useful in blasting out stumps on the land they were clearing for vineyards, scented devil's work.

Despite this lack of enthusiasm, before long Freiburger gunners were famous all over the country, and cannon, probably some of the first ever used, were being fired from the Schwabentor at the castle on the Schlossberg (1366), where Freiburg's Count Egon was defying the city. In the back of the cloisters a room is still pointed out as Berthold's "powder kitchen."

Another interesting religious monument is the Baselhof, a beautiful Renaissance building used as a cloister by those monks of Basel who refused to subscribe to the Reformation. For a number of years the long-nosed, stringy-necked scholar, Erasmus, lived here.

The Baselhof always seems to me typical of Freiburg's real feeling for its glorious past; for, although it is now so prosaic a place as police headquarters, its outward appearance remains unchanged. On the magnificent doorway is an embossed and painted coat of arms. On the deep, terra-cotta front are decorations of knights in armor, angels, and saints. In a niche



 Natural Color Photograph by Hans Hildenbrand

QUAINT MITTENWALD EXPORTS VIOLINS AND ENTERTAINS MOUNTAIN CLIMBERS

The tiny town near the Tyrol (Tirol) border also is famous for its guitars and zithers, made for generations in its queerly façaded homes. The steep Karwendel Mountains offer many venturesome, but alluring, trails.

Natural Color Photograph by Hans Hildenbrand

OVER THESE MOORS AND FENS THE HANOVER KINGS ONCE HUNTED

This bleak area, dotted with oases of beech and oak, extends north from Hannover (Hannover) to the Elbe. On its grasslands graze the celebrated Heidschnucken breed of sheep. For more than a century before Queen Victoria was crowned, Hanover and Great Britain had the same rulers. Then, as the Hanoverian law required a male monarch, Ernest Augustus, Duke of Cumberland, was elevated to the Hanover throne.

FROM A FOUNTAIN FLOWS VILLAGE GOSSIP

The group is wearing the Swabian folk costumes. Men often have suede leather breeches, supported by embroidered suspenders. Back of the fountain is the City Hall of Gross Bottwar, Württemberg.

Natural Color Photographs by Hans Hildenbrand

A GATE ENCOURAGES CONFIDENCES

The two women with the glistening starched collars, peaked headdresses, and elaborately embroidered aprons of many colors, are residents of Bückeburg, capital of the tiny State of Schaumburg-Lippe, northern Germany.

Natural Color Photograph by Wilhelm Tobien

HEIDELBERG CASTLE RECALLS MEMORIES OF DEPARTED CENTURIES

Since early in the 13th century, portions of the castle have crowned the mountain spur overlooking the Neckar River. The Otto-Heinrichs Building (right), the Glass Hall Building (center), and the Fredericks Building (left), however, were built in Shakespeare's time.

Natural Color Photograph by Hans Hildenbrand

TULIPS NOD TO FORGET-ME-NOTS IN A BADEN GARDEN

Situated in the beautiful valley of the Oos and rising terracelike on the mountain slopes, Baden has long been known as the "Pearl" of the old Grand Duchy of Baden. Thousands of visitors are drawn annually to its hot mineral spas, famous since Roman conquerors built elaborate baths on the site.

Natural Color Photograph by Hans Hildenbrand

RHEINSTEIN CASTLE SILENTLY GUARDS THE RHINE NEAR BINGEN

Although its origin is lost in conflicting folklore tales, the lofty stronghold had historical mention as early as 1279. Within its vine-clad walls are exhibited suits of armor, weapons, trophies, and paintings. It is the property of Prince Henry of Prussia.

Natural Color Photograph by William Tobien

MILTENBERG, ON THE MAIN, STANDS ALOOF FROM MODERNISTIC ARCHITECTURE

With its fine old well in the market place and the aged timbered houses, set with window boxes, the town preserves its 16th-century atmosphere. It also proclaims "the oldest hotel in Germany," the Hotel of the Giant, in which Luther, Gustavus Adolphus, and other notables have stayed.

Natural Color Photograph by Hans Hildenbrand

THE CHIEF MARKET IN NUREMBERG (NÜRNBERG) IS A PLEASANT PLACE TO SHOP FOR FLOWERS AND VEGETABLES

The Neptune Fountain, around which the venders have banked their stalls of produce, is a copy of the original fountain that was sold to Russia and set up in Leningrad. In the background rises the Liebfrauen Church, completed more than a century before Columbus set sail.

Natural Color Photograph by Hans Hildenbrand

A SPIRE NEARLY AS LOFTY AS THE WASHINGTON MONUMENT

This largest of German Gothic churches, except the Cologne (Köln) Cathedral, is a monument to Ulm's greatness during the late Middle Ages. The tower rears its slender stone wedge 528 feet from the ground, outtopping all other church steeples of the world. From a circular gallery, 58 feet from the top, visitors can see the Alps on a clear day, and a signal is hoisted when such visibility exists.

 Natural Color Photograph by Hans Hildenbrand

NOT VENICE, BUT HAMBURG!

Many canals, fed by the Elbe, flow through this most important of the three Hanseatic towns, now the second largest city in Germany. The rich Gothic pile of the Nikolai Kirche (St. Nicholas) stands in the distance.

beside one of the two irregular bays is a gilded statue of the Virgin, with a warrior on her right and a bishop on her left.

Only recently did I discover that the back of the building is as impressive as its front. On my way to market—most of my adventures take place on my way to market—I met a policeman leading off two men. So intent was the officer on his charges that he didn't notice me, as I slipped into the rear entrance of police headquarters on his heels; and before I was observed I had found a lovely scene direct from the Middle Ages—cloisters encircling a square courtyard, a crooked bay with tiny, slanting windows, and an exquisite stone doorway adorned with a beautifully carved Virgin and Child and some fat little angels. It opened on a winding staircase with an elaborate balustrade in red and green and gilt.

Not all Freiburg's historical monuments are churchly.

THE BUTCHER'S SON WHO PUT "AMERICA" ON A MAP

Martin Waldseemüller, the geographer who was the first to put the name "America" on a map, was a Freiburger, and his ancestral dwelling not only still stands but flourishes. Martin's father was a prosperous butcher, who apparently held views unpopular in Germany even then, for he was known as "King of the Jews" and met a violent death.

The family were at the time living in what is now No. 9 Löwenstrasse, then the Pike's Head House, and Martin was a student at the newly established Albert-Ludwig University. Later, when Waldseemüller's "Cosmographiae Introductio" and the world map,* on which for the first time the newly discovered Western World was called "America," became famous, neighbors probably remembered that a family of that name had lived on their street. But it was only recently that a tablet was placed over the door of the little two-story yellow house, stating that here from 1480 to 1492 dwelt Martin Waldseemüller, who in his famed World Atlas of 1507 bestowed on the continent of America the name it bears.

It is a beauty shop now, with a shiny brass dish, sign of the hairdresser, swinging over its door. No one looking at its positively "prissy" front would dream that it had weathered the storms of 450 years (see page 241).

The Whale House—why "Whale" I have never been able to find out—is probably the most spectacular of all Freiburg's lay monuments. It was built by Kaiser Maximilian I, but only three years after its completion he died, in 1519. Save for a brief month when Maximilian's grandson visited Freiburg, it was never occupied by royalty. But the place has been meticulously kept up, and now, one of the town's largest savings banks, it stands, all warm red and glittering gilt, a classical example of the dwelling of a prosperous medieval noble.

THE "OLDEST INN OF GERMANY"

Close to the Schwabentor is the Bear, generally conceded to be the oldest inn in Germany (page 232). There it is, a deep-yellow, three-story stone building with a high, dormer-windowed roof and maroon shutters, set slightly edgewise and bulging a little with the bend of the street; but natty withal and rather snapping its fingers at the 550-odd years that are chalked up against it.

The Bear Inn appears on Freiburg's town records as a going concern in 1390, and since that date the names of its proprietors are all on file. This is something of a miracle when you consider that the poor old Bear has kept his ground with his back against the city wall and his nose uncomfortably near the city's most vulnerable gate, and that he has survived not only the onslaughts of Austrian, French, and Swedish armies, but the undoubtedly hit-or-miss performances of Black Berthold's cannon.

All Freiburg's old buildings carry their age well, though, and are singularly lacking in a depressing museum atmosphere. They are kept up and painted, and, above all, lived in. About them hangs a jaunty air of character and usefulness such as you see in sturdy old people who refuse to be shelved. The Kaufhaus (Merchants' Hall) in the Münsterplatz, an amazing example of Late Gothic in bright red and gold, since it was begun, in 1524, has been a trading center for the Schwarzwald farmers (216).

The flat-faced yellow Kornhaus, or Granary, across the square, with its enormous step gables and its red trimmings, was completed the year after John Cabot visited North America. To-day, as always, it is

* See "The Story of the Map," in the NATIONAL GEOGRAPHIC MAGAZINE for December, 1932, with special map supplement of the World.

Photograph by E. Baumgartner

"ON SALE" AND "OFF SALE" SINCE 1390

Just within the venerable Schwaben Gate (see page 215) is the Bear Inn (left), which proclaims itself the oldest in Germany (see text, page 231). Recently the linden tree here shown was given a ceremonious 200th-birthday celebration. To the golden bear over the door of the inn the tree must seem a newcomer, for the hostelry was a going concern a century before Columbus sailed for America. There is on file an unbroken list of its proprietors since that time. In the right foreground is a trench for the running streams that traverse many streets (see pages 216, 217).

the place where the market people store their wares. The mellow buff building beside it, which was old Freiburg's orphan asylum, has become a very dignified public library.

MEDIEVAL MONKS SOLVED EMPLOYMENT PROBLEM

Freiburg and the surrounding country has the Church to thank for industries as well as for monuments.

With the spread of Christianity, monasteries sprang up all over the Schwarzwald. Now, although the Rhine Valley plain is known as the "Garden of Germany," the Schwarzwald is in an entirely different category. Bordering the streams the slopes are steep, timber-covered, and not conducive to agriculture.

The flatter uplands, as in our own New England States, were once ice-covered and are consequently stony and not highly pro-

Photograph by Emil F. Albrecht

AN ANCIENT CITY GATE RISES IN "MAIN STREET"

The Martinstor is one of the two remaining city gates (see illustration, page 215). Through it passes the principal street of Freiburg, which, oblivious to changes of government, keeps its historic name, Kaiserstrasse.

ductive. That the land was not capable of supporting a large population was early recognized by a law prohibiting the splitting up of farms among the descendants of their owners. In those days the land used to and still does go down to a single owner, leaving the rest of the family to shift for themselves.

Soon the surplus population, scenting a market for foodstuffs as well as for labor, settled about the monasteries in swarms, and the monks found themselves saddled with an unemployment problem, which they solved so successfully that in time Schwarzwald industries became famous the world over.

The occurrence of timber and abundant clean sand started the glass industry. During the Age of Discovery the manufacture of glass beads for barter with the American Indians fanned this industry to fever heat.

The exploitation of silver-lead veins opened up a mining district which was once important and which was worked until a few years ago.

A MONUMENT TO FREIBURG'S DEVOTION TO MUSIC

With a population of only about 100,000, the city keeps its Municipal Theater open, giving daily performances from September until July. This building was erected in 1910.

Photograph by E. Baumgartner

THE "WEDDING MAN" MUST BE A SALESMAN

Black Forest wedding invitations are delivered by word of mouth and each guest pays his way. The announcer, who also is the collector, puts on his Sunday best and a special hat reserved for such occasions.

A STUDY IN BONNETS

The chic thing in Black Forest millinery has a touch of gold in the back, and long black ribbon streamers, often carried over the arm to keep them from trailing in the dust.

THE COFFEEPOT IS KEPT BOILING

This kitchen is considered very "new-fangled" by the neighbors because a modern cookstove, with a pipe that carries the smoke outdoors, has superseded the old stone range. Many of the older houses still lack chimneys.

MANY WAYS ARE NARROW, BUT SELDOM STRAIGHT

In the days of frequent invasion, citizens found it easy to shower missiles on the heads of enemies. The heavy beams across the street help support the walls of the ancient houses. The buildings often bear the names and dates of their successive owners through the centuries. In this passage the water trench is to the left.

Water power led to gem-cutting. The house occupied by the Guild of Gem Cutters still stands, and when Marie Antoinette passed through Freiburg on her way to France to marry the Dauphin, the burghers presented her with a thousand cut garnets. To-day in near-by Waldkirch is a large gem-cutting establishment. This same water power has been used for nearly 200 years to run Freiburg's silk-thread mills.

Forests made lumbering, clock-making (Schwarzwald clocks have wooden wheels), and woodcarving possible. Even in the Middle Ages Schwarzwald timber-drivers delivered their log rafts as far away as Rotterdam.

Sheep led to hat-making and weaving, willows to basket-making; and the Schwarzwald peddler, carrying hats and cloth, baskets and clocks, glassware and silver ornaments, was known at every door in Europe.

Even now handwork goes quietly along on a small scale in the forest, as if there had been no Industrial Revolution. In their own houses, men and women make clocks and music boxes and furniture, as well as funny little wooden toys that delight the heart of the most blasé and hardened child.

They weave, too, and stamp the cloth with wooden-block patterns, some of which have been in the same families for generations. I saw a piece of linen blocked with alarmingly realistic scenes from the Resurrection, and a friend showed me a tablecloth, used only at Christmas, on which the whole lovely Christmas tale—Infant, Shepherds, Wise Men, camels, and everything—was all hand-blocked.

VINEYARDS IN THE HEART OF THE CITY

The monks also planted the first-known vineyards of the district. As far back as the eighth century there are vague accounts of grape-growing and wine-making in Breisgau, but the earliest official record of such activities comes from the Holy Ghost Hospital in the middle of the 13th century.

The most distinctive note of the Freiburg wine industry is that some of the vineyards are actually a part of the city. In Colombi Park, almost the center of town, the sunny slopes are thriftily planted with vines that yield a particularly delicious wine, and the Schlossberg vineyards roll down to the Schwabentor.

A friend of mine, who lives not more than ten minutes' walk from the Berthold Fountain, had last fall a wine harvest of more than 790 gallons from the grapes growing on the hillsides behind her house (p. 248).

Most of the best wines of the district are white, or rather a delicate, fragile gold. And this fine wine has the signal virtue of being amazingly cheap.

So that's that for Freiburg's romantic past, which overlaps its present so neatly that the seam hardly shows. It also carries us on to her claim to jollity.

This claim depends upon one's standard of jollity. If you are a student, you will find all that the heart could desire in the way of gaiety, typical college gaiety that doesn't seem to vary a hair's breadth the world over. But if you are seeking sophisticated night life, Freiburg will leave you cold; for it is essentially a university town and a place of retirement for people of wealth and position.

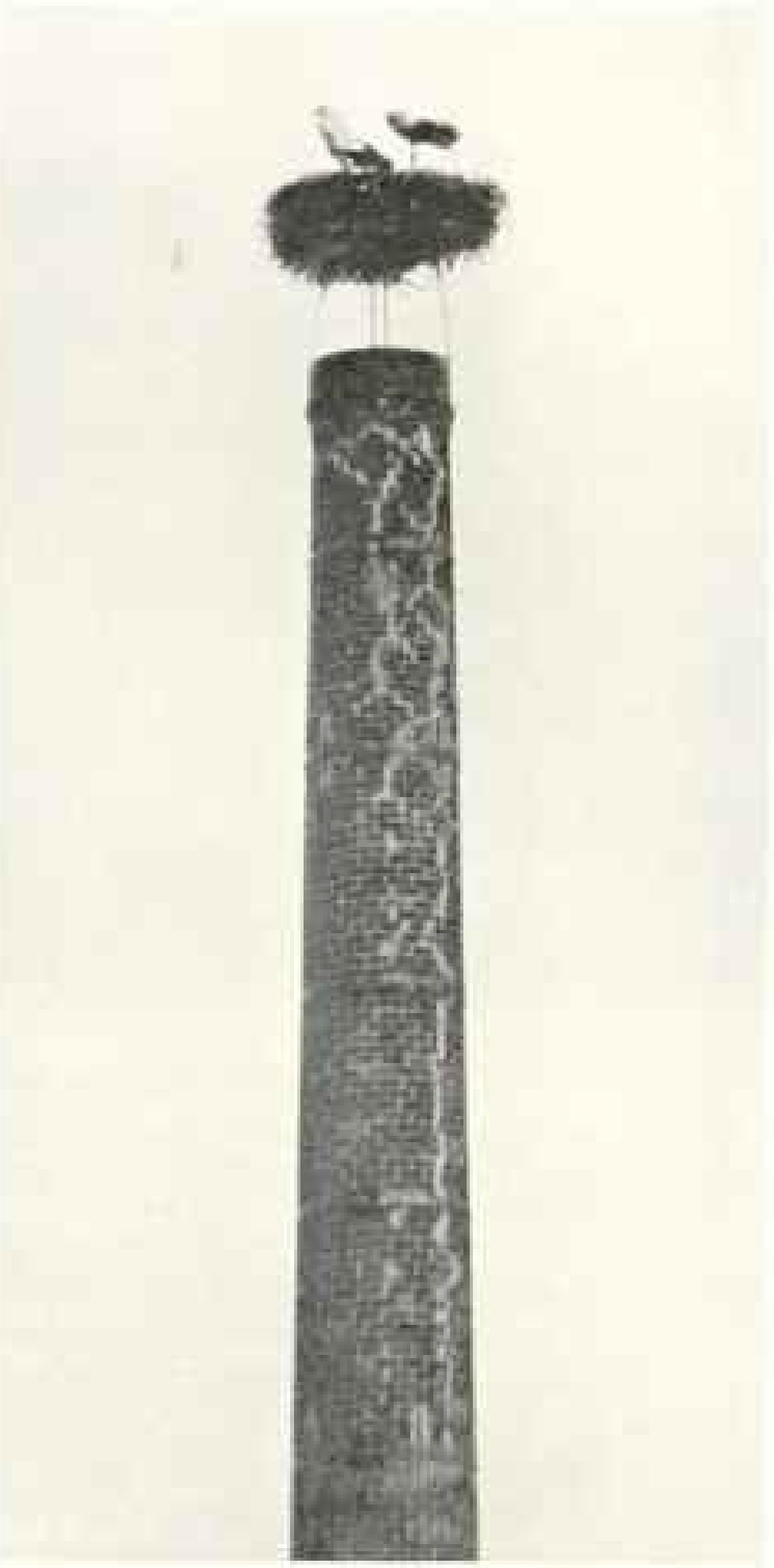
Before the World War, a hundred millionaires and I don't know how many generals, not to mention a grand duke, lived here. The glory of those halcyon days is attested by long, stately, tree-lined streets outside the old city, and by enormous houses of elegant, if uncertain, architecture set in lovely gardens. People still retire to Freiburg for rest and peace, but most of the great houses, reduced by the leveling hand of poverty, are closed or cut up into flats.

So, aside from student activity, Freiburg's jollity is of a quiet, middle-aged nature, and after Paul at 10 has rung the bedtime hour (see text, page 222), the streets are usually deserted, unless it be for the throngs pouring from the Municipal Theater (see page 234).

The present theater, an enormous modernized baroque monument of yellow sandstone to Germany's almost sacrificial passion for music, was completed in 1910. It seats about 1,200 people, its acoustics are perfect, and a clear view of the stage is possible from the cheapest seat in the house.

The things, however, that really make Freiburg a "jolly little town" are matters less material than night life or even music.

The place is delightfully neat. I have lived here a year now and I have never found even an approximate slum. The streets, down to the smallest, are immaculately clean, and during the warm weather flowers are everywhere—in the City Gardens, in the park along the Dreisam, in the open squares, and in rioting masses at all the windows, up to the tiny dormers high on the roofs.



Photograph by E. Baumgartner

THE STORK IS THE FOREST FAMILY EMBLEM

As in parts of northern Europe, the birds are considered a token of good fortune, and if they leave it is regarded as a premonition of evil.

FOREST PROVISION FOR HIKER AND CAMPER

The surroundings of the city, too, are charming. Right to its stately medieval gates sweeps the Schwarzwald, mile upon mile of pine, spruce, and fir, practically all owned by the Reich, but beautified and made accessible by the Black Forest Association.

Between tall, clean-limbed trees, unimpeded by underbrush, paths branch out through this vast forest.

At every cross-trail is a signpost carefully marked with directions and distances; and all the recognized hikes are designated by definite insignia, so that by following your red or blue diamond, or your green or yellow circle, you will be certain to arrive at your appointed destination.

At every vista, too, the Association has placed rustic benches, where you may rest and look down on the valley of the Dreisam, flat as a floor and dotted with small villages; or up at the encircling mountains,

Photograph by E. Baumgartner

MODERN EDUCATION THRIVES IN ANCIENT FREIBURG

The red sandstone Administrative Building of Albert-Ludwig University was completed in 1911. Other buildings are widely scattered through the city. The University enrollment last year exceeded 3,000 (see text, page 243).

often snow-capped long after the cherry trees are in bloom; or across the vine-clad hill district of the Kaiserstuhl, beyond which is the Rhine.

On a sunny or, even more thrilling, a snowy week-end or holiday, the entire population turns out. Railway fares, always cheap, are for these special occasions pared down for families and students, and the rattly third-class coaches, which always seem to be running on a flat tire, are loaded down with joyous young folk bound, perhaps, for historic Breisach and a swim in the dangerously swift Rhine, for a dip or a skate at Titisee, or for a ski run on the Feldberg, highest peak of the Schwarzwald.

BICYCLE TRIPS ARE POPULAR

Bicycle trips are in high favor, and neither age nor position deters a German from mounting his trusty "bike" and taking to the road. It is a rare sight on market days to watch the peasant women, enormous skirts bellying in the wind, hat streamers whizzing out behind, not infrequently a cotton umbrella deftly balanced over a head, cutting the air at 12 miles an hour as they pedal into town.

Then Germans, both old and young, still walk, and on holidays the roads and forest paths are full of singing boys and girls, stolid parents with children at their heels, and settled men and women loaded down with knapsacks and packages of food.

To accommodate these travelers, all sorts of economical and comfortable arrangements are made. For those under twenty who hold properly authorized tickets and who travel on foot, by bicycle, or boat, but *not* by auto or motorbike, are the *Jugendherbergen* (Youth Hostels), where for less than 15 cents one can get a bed, a clean pillow slip, and a blanket buttoned into a clean sheet, as well as the privilege of cooking on the big ranges and eating at the clean, bare tables.

Older, but also economically minded people, patronize the *Naturfreunde Häuser* (Friends of Nature Houses), where accommodations are equally cheap. For more affluent travelers there are wayside inns.

It is undoubtedly "swell" to amble over the beautiful countryside, past enormous farm buildings with the stable and living quarters under one roof and the manure pile rearing nobly to the second-story windows; past lush fields where more or less resigned cows and openly resentful horses

Photograph by E. Baumgartner

WHERE MERRY WIDOW STYLES SURVIVE

Going to church constitutes a fashion show of Gutach village. Enormous pompons of scarlet wool bedeck the severe white straw hats. Black velvet jackets are embossed with red and white flowers, and short silk aprons are worn over the billowy, figured skirts.

together plow the heavy earth; past roadside shrines and Stations of the Cross; past villages where people wear the quaint old Schwarzwald costumes without self-consciousness; so swell as to make one wonder why legs as a means of locomotion have been so ruthlessly discarded in our own country.

On one of these amblings I had a curious experience. My husband and I had been cruising about the old silver mines near Staufen (the town in which Faust died), when a sudden storm drove us into a small farmhouse for shelter.

We were hospitably received by an old, old man and his little old wife, who seated us on the bench that ran around the big porcelain stove, and with great enthusiasm voiced what appeared to be expressions of welcome.

But the trouble was we couldn't understand a word they said, and it was soon apparent that none of our neatly enunciated German took with them.

"They're speaking Alemannic, one of the oldest of the German dialects," my husband told me at last. "I know that some of the very old people still use it, but I never heard it but once before."

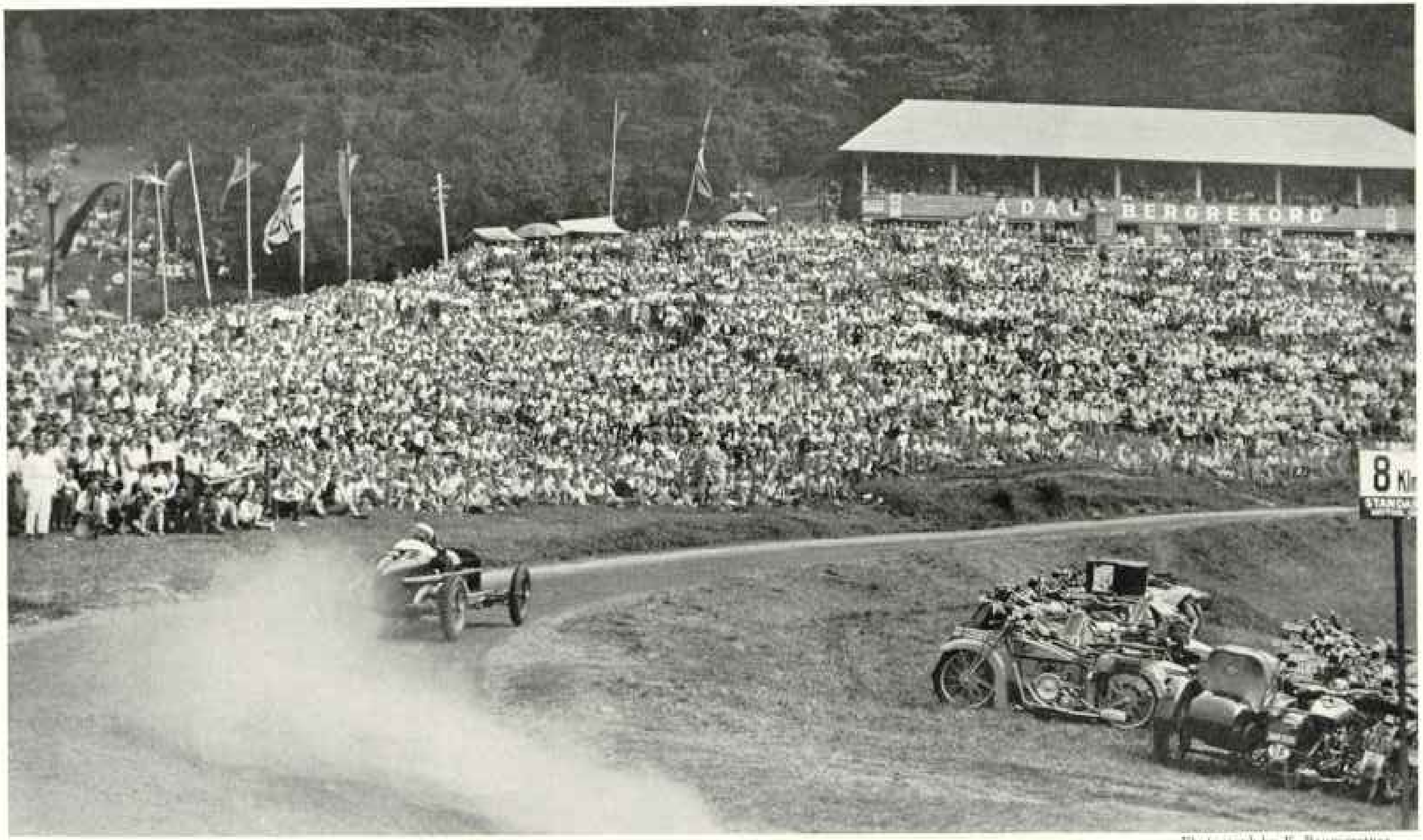
The situation might have been painful, had not the old man risen to it. Lumbering over to a little cabinet that stood in the Herrgottswinkel (God's Corner, where the Crucifix is hung), he drew forth a package.

With toil-thickened, clumsy fingers he untied the string, removed the crackling brown paper, and disclosed to our startled eyes two thumbed and yellowed copies of the NATIONAL GEOGRAPHIC MAGAZINE.

EARLY TO SCHOOL—AND SHORT VACATIONS

My first reaction to German schools was a heartfelt wish that they would not start so early. Eight o'clock, especially on a cold, dark, winter morning, did seem rather awful; but as the school day ends at one, I soon got used to the early start. The school year begins after Easter, and the summer holidays are a mere six weeks, running from the 1st of August to about the 10th of September.

German children attack education earnestly. All of them, save those certified by a doctor as either mentally or physically deficient, start their education in the public school at the age of six. There they must remain for eight years, unless they expect to go in for advanced learning. In that



Photograph by E. Baumgartner

WHERE MOTORS AND CYCLES TEST CLIMBING QUALITY

The Lookout Mountain (Schau-ins-Land) near Freiburg is the scene of a famous contest each summer, in which vehicles of many nations are entered. On the stand are the initials, A. D. A. C., of the automobile club which sponsors the races.

Photograph by Alicia O'Reardon Overbeck

HERE LIVED THE "GODFATHER OF AMERICA"

Martin Waldseemüller, the geographer who first put the name "America" on a map, was a son of Freiburg. His family was so large it occupied these two houses, 9 and 11 Löwenstrasse. For a reproduction of the Waldseemüller map, see the NATIONAL GEOGRAPHIC MAGAZINE for December, 1932.

Photograph by Emil P. Albrecht

LIFE IS LEISURELY IN FREIBURG

The arcades of the Merchants' Hall, the street venders of flowers and vegetables, and the leisurely buyers create an illusion of our South. That is dissipated when the eyes are raised to the second-story bay windows and the lofty step gables, fine examples of the Gothic style.

WHEN COWS MUST WORK IN THE FIELDS

For plowing two milch cows are usually used, but for hauling a cow and horse are the customary combination.

STRAW WEAVING IS A HOUSEHOLD INDUSTRY

The practice started in 1716, when a returning peddler brought a straw hat as a model from Italy. Previously Black Forest peasants had worn felt; quickly they turned to straw. The itinerant salesmen who formerly roamed far and wide over the Continent selling clocks (see page 249) introduced many other new ideas, including the effort to raise canaries on a commercial scale. The corner shrine and the large window area are characteristic of Black Forest homes.

case they can leave public school at the age of ten and enter one of the three types of secondary school, where they can immediately launch into Greek, Latin, French and English. The tuition in these higher schools is about $48 a year, and the course covers nine years, making the average student nineteen when he enters the university.

Between German and American universities the gulf is even wider than it is in the secondary schools. The year is divided into two semesters — the winter semester, from November until the end of February, and the summer semester, from April to the end of August. The minimum time required to secure the Ph. D. degree is eight semesters, whereas the medical degree usually takes ten semesters. No examinations are given until the end of the fourth semester, and during these first two years students are encouraged to move from university to university.

IT MIGHT BE AN AIRPLANE

However, such wide black ribbon bows, with fringed ends, were worn by maidens of some Black Forest villages long before man took to the air.

From the day a student embarks on university life he is entirely on his own. He may sign up for what lectures he sees fit, and after signing up he may attend them or not, as he sees fit. No one tells him what to do or when to do it; no one tells him where to live or how.

Notwithstanding this liberty, German students are a serious lot. I am always impressed, not only by their active interest in lectures, but in the active way in which they show their interest. Here, in Freiburg, when the professor enters the lecture room he is greeted by a discreet tattoo of feet on the wooden floor.

As he warms to his subject, his audience warms with him, and a hearty slapping of feet encourages him to further flights. But if he grows tedious or runs over his allotted time, he is warned of his lapse by a steady and continuous scuffing.

Freiburg's University, the Albert-Ludwig, was founded in 1457. Then, as now, it was scattered about the city. In 1911 the present Administrative Building was completed (see page 238), but many of the departments are under different roofs, and some remain in the Jesuit Monastery that was the main building in the 18th century.

As late as the end of the 19th century the University rarely had more than three hundred students. This past winter the

WHERE THE HIKER IS KING

Paths in the Black Forest are graded and benches are placed at every vista. At cross-trails are signposts, marked with directions and distances. Recognized hikes are designated by special insignia (see text, page 237).

enrollment was 3,326, of whom 53 were Americans. Lack of employment is responsible for an enormous expansion in all German universities, and the attendance at the various higher institutions has mounted to something over 110,000.

EDUCATION A REFUGE FOR THE JOBLESS

Thousands of German boys and girls are being educated to the saturation point because there is no other outlet for them, and not a few of these students live on pitifully small sums. To such students the University offers much and varied assistance. The student card, which is included with tuition, provides medical care and hospitalization. The "Mensa Academica" serves, for twelve cents each, lunches and dinners of stout soup and a choice of three nourishing dishes, but no dessert.

Just inside the door of the Jesuit Monastery, the part of the University that I know best, is a small bureau where students can have their clothes repaired, cleaned, and pressed for almost nothing; or, if that almost nothing is too much, facilities for doing the work themselves are placed at their disposal. Through the University, anything from skis to typewriters and textbooks can be borrowed for a pittance, and in extreme cases students are provided with food and service entirely free.

SKIERS THRONG TO FELDBERG'S SUMMIT

Over the week-ends, when the treeless, low-domed top of the highest mountain in the Black Forest is covered with snow, the buses are crowded and their tops are piled high with skis.

Photograph by E. Baumgartner

DUELING AGAIN IS PERMITTED

Representatives of the dueling societies of the University add color to many public gatherings. The pointed swords carried on parade are not those used in the encounters. The small caps, also, are reserved for festive occasions (see text, page 246).

Photograph by E. Baumgartner

WHAT IS WRONG WITH THIS PICTURE?

The coffee cups of this student society, on an outing in a Freiburg park, contradict the impression that the German collegian always drinks beer. Such excursions, to the parks and numerous inns, are popular during the summer semester.

German universities have nothing that approximates our intercollegiate sports, nor any of our "dear old Alma Mater" spirit, probably because most students have attended two, three, or even four universities before attaining their degrees. Student loyalty is confined to societies which superficially correspond to our fraternities.

In Freiburg these societies are divided into nine major classifications, with a total of about 85 groups, and each group has its special cap—caps of colors so lurid and shapes so fantastic that you wonder if the Mad Hatter hadn't a finger in the pie. There are singing societies, gymnastic societies, societies of various church denominations, and possibly twenty-five dueling societies.

DUELING AGAIN IS LEGAL

Although student dueling was banned after the World War, the practice went merrily along; and now, under the Hitler régime, it has again been declared legal. There are two kinds of duels—friendly affairs, where the principals are bandaged to the chin and the two-edged sword, unpointed, but sharpened on both sides, is manipulated from above the head; and honor affairs, where the amount of bandaging and the nature of the weapons (pistols or sabers) is decided by the gravity of the insult that has provoked the duel (245).

Between love and honor, the young gentlemen manage to hack each other up pretty successfully; but in Germany a duel-scarred face is regarded as an asset. My daughter was telling me about an Adonis who lives in the fraternity house opposite her school.

"He's so handsome, Muddy," she sighed. "*So* handsome! Why, his face is simply carved with dueling!"

CITY MARKETS—AND ERASMUS

Before leaving Freiburg I must mention a few of the things that make it so *gemütlich*, that delightful blanket word that means comfortable, cozy, homelike, livable.

Take Freiburg's markets. Nothing could be more gemütlich than the great City Market that has assembled in the Münsterplatz ever since there was a Freiburg. On Saturdays and Wednesdays, the best market days, the cobbled square is covered with stalls protected by cotton umbrellas or makeshift awnings, on which are piled crisp, newly picked vegetables, delicious fresh fruit, fish that might be improved

Photograph by E. Baumgartner

A SHINGLE CUTTER AT WORK IN THE BLACK FOREST

In an area which is poor in minerals, forest products have been utilized in many household industries (see text, page 236). The cutting of shingles boomed a few years ago, when thatch roofs were prohibited because of the fire hazard.

THE GEM CUTTER'S POSITION IS AS DISTINCTIVE AS THE TAILOR'S

In past centuries Freiburg was a renowned center of garnet cutting. Marie Antoinette, passing through the city on her way to marry the Dauphin, was presented with a thousand garnets. The author was able to elicit no satisfactory explanation of the workers' posture beyond a surprised "Why, it has always been done that way!"

BEYOND THE GATE LIE VINEYARDS

One may step from busy streets through the Schwabentor into this rustic setting. Next to its trees, its vines constitute the principal source of revenue of the Black Forest. The monks were the first to plant vineyards in the Freiburg district (see text, page 236).

Photograph by E. Baumgartner

BROTHER BERTHOLD, OF THE BLACK ARTS

German writers acclaim him the inventor of gunpowder, though Roger Bacon also has been credited with the discovery. While experimenting in his cell in Barefoot Cloister, which still stands, he exploded his retort with a mixture that he later developed into a charge for firearms (see p. 222).

Photograph by E. Baumgartner

AS THE CLOCK PEDDLER USED TO LOOK

A Black Forest citizen dons the costume and pack that once were as well known all over the Continent as the scissors grinder in America. The clocks had wooden wheels and the product had a new impetus when, early in the 17th century, the cuckoo clock was introduced.

THE BASKET MAKER WORKS IN STRAW SHOES

The worker sits on the bench that customarily runs around the porcelain stove, stoked from the adjoining kitchen, into which the smoke escapes. Only the newer houses have chimneys. The space beneath the benches is used for storage (see illustration, page 235).

Photograph by E. Baumgartner

LOFTY FORTIFICATIONS STILL GUARD ONE OF EUROPE'S MOST FAMOUS FRONTIERS

The town of Breisach (Alt-Breisach) has grown over and around the elevation on the Rhine, which has been a stronghold since the earliest feudal lords held these lands. Louis XIV stopped to view the town on his way to inspect the fortifications erected by Vauban at Freiburg, which lies east of this crossing. The old Cathedral dominates the town. The traffic jam of river craft is an evidence of German enthusiasm for the outdoors.

A BOW MAKES A BONNET

This simple headdress of black ribbon is usually worn by grandmothers in the little town of Oberharmersbach, north of Freiburg. In the Black Forest fashions do not change with the season, but with the locality of the wearer (see illustrations, pages 235, 239, and 245).

Photograph by E. Baumgartner

THEIR HATS LOOK LIKE A NEW BEACH STYLE

For generations the women of Villingen, in the Black Forest, have worn straws of this design and embroidered shawls. Beneath the hats, around their necks, and from their cuffs protrude the ruffles of which German women are so fond.

by a bit of ice, tripe, poultry, rich, dark-brown Schwarzwald honey, and mountains of flowers (see page 214).

With a familiarity born of long acquaintance, the butchers set up their stalls in the shelter of the Cathedral buttresses, under the beautiful rose window.

The old woman who sells healing herbs has established herself inside the magnificent porch, along with the Twelve Apostles and the Wise and Foolish Virgins, and girls in charming costumes, which are different in almost every village, rest on the steps in the shadow of the Last Judgment.

The venders of cream and butter and eggs and cheese squat around the Renaissance fountain, their wares laid out in leaf-lined baskets or set to cool in the clear, chill water. Under the Kaufhaus arcades traders in anything from votive candles and canaries to sauerkraut and onions do business (see page 216).

Aside from the regular City Market, there are the seasonal markets, the apple market, in Karl Square, where in autumn the Schwarzwald farmers bring their harvest, or the potato market, in a lovely little hidden square, with an old, old fountain and a clump of plane trees—a square so securely hidden that I almost missed out on my winter potatoes. The story is that Erasmus loved this sheltered corner.

A PRETZEL IS THE INSIGNIA OF BAKERS

Then consider Freiburg bakeshops. There's individuality, there's character, in these bakeshops. Bread is made from recipes that go back to the days when the Bakers' Guild was one of the city's most important organizations, and each baker has his specialties, for Freiburgers are great bread eaters, taking it, unbuttered, even with their wine.

At the Christmas season the bakeshops are particularly ravishing with delicious, crispy brown St. Nicholases, spicy ginger Infants, and pretzels as big as cartwheels.

The pretzel, by the way, is the sign of the bakeshop, and over every establishment swing large gilded ones. In the Cathedral is a stained-glass window, memorial to the Ancient Guild of Bakers, chastely decorated with two rolls and a pretzel!

Freiburg's element of surprise is another joy. Now, at the close of a year, I'm always coming across something new—an age-stained fountain with a monkey reflectively watching the water trickle through the coconut in his hand; a gray wall embossed with the coat of arms of the Zähringens; a breath-taking view of the Cathedral spire from a framework of trees; an exquisitely decorated little chapel tucked away in the grim old Peterhof Monastery.

But what makes Freiburg most gemütlich is the friendliness of its people. If your German is poor, they make every effort to understand it and never laugh when you say silly and sometimes disconcerting things. The shopkeepers are patient if you don't know how to count your change, patient and flawlessly honest. As you gradually rise to the status of a regular customer, they call you "Frau Doktor," or "Frau Professor," or even "Baronin," according to the measure of their affection.

The policemen and tram conductors, contrary to the usual opinion of German officials, are the most polite—I almost said the most courtly—of their species I have ever encountered.

Regularly on my way to town I take the last lap to the tram on a light gallop, the motorman clanging his bell and the conductor from the back roaring encouragement; and when at last I make it, I am hoisted aboard unrebuked, greeted cordially, and led to a seat amid the pleased clucks of the other passengers.

Or, again, my errands in town completed, I may meet my tram midway between stops. Does that Freiburg motorman coldly pass me by? He does not. Instead, he slows up his vehicle so that I may comfortably run alongside to the next stop.

If these attentions were lavished on me alone I might grow haughty and purse-proud, but they are not. Hardly a station on the trip to town but some lady or gentleman, snorting and slightly purple, is hauled aboard and seated. Of course, it slows up the journey a bit, but anyone will acknowledge that it is gemütlich.

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IMMEDIATELY after the terrific eruption of the world's largest crater, Mt. Katmai, in Alaska, a National Geographic Society expedition was sent to make observations of this remarkable phenomenon. Four expeditions have followed and the extraordinary scientific data resulting given to the world. In this vicinity an eighth wonder of the world was discovered and explored—"The Valley of Ten Thousand Smokes," a vast area of steaming, spouting fissures. As a result of The Society's discoveries this area has been created a National Monument by proclamation of the President of the United States.

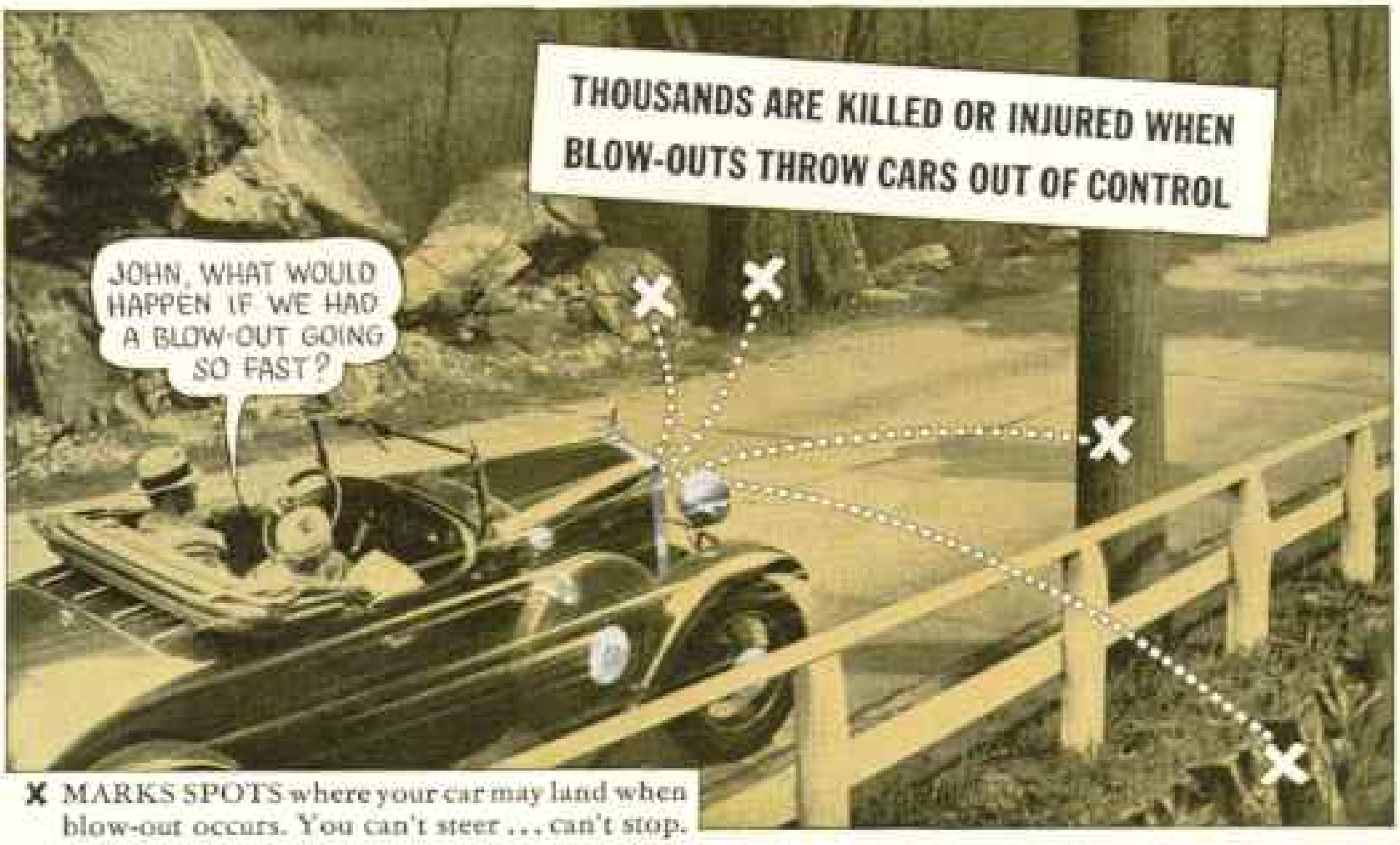
AT an expense of over $50,000 The Society sent a notable series of expeditions into Peru to investigate the traces of the Inca race. Their discoveries form a large share of our knowledge of a civilization waning when Pizarro first set foot in Peru.

THE Society also had the honor of subscribing a substantial sum to the expedition of Admiral Peary, who discovered the North Pole, and contributed $55,000 to Admiral Byrd's Antarctic Expedition.

NOT long ago The Society granted $25,000, and in addition $75,000 was given by individual members to the Government when the congressional appropriation for the purpose was insufficient, and the finest of the giant sequoia trees of California were thereby saved for the American people.

THE Society's notable expeditions to New Mexico have pushed back the historic horizons of the Southwestern United States to a period nearly eight centuries before Columbus crossed the Atlantic. By dating the ruins of the vast communal dwellings in that region The Society's researches have solved secrets that have puzzled historians for three hundred years. The Society is sponsoring an ornithological survey of Venezuela.

TO further the study of solar radiation in relation to long range weather forecastings, The Society has appropriated $65,000 to enable the Smithsonian Institution to establish a station for six years on Mt. Brukkaros, in South West Africa.



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"The English stewards were noticeably satisfactory . . . prompt, willing, and genuinely interested in our comfort and welfare.

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"I consider the itinerary exceptionally well planned. I took a good many movies, and, out of 5,000 feet of film, had to cut only fifty as being insufficiently interesting to show to my friends."

Travellers who know how to judge ships will sail again this year on the 1934 cruise of the Empress of Britain. Why not join their company . . . make new friends . . . see the world? It costs very little more than decent living at home.

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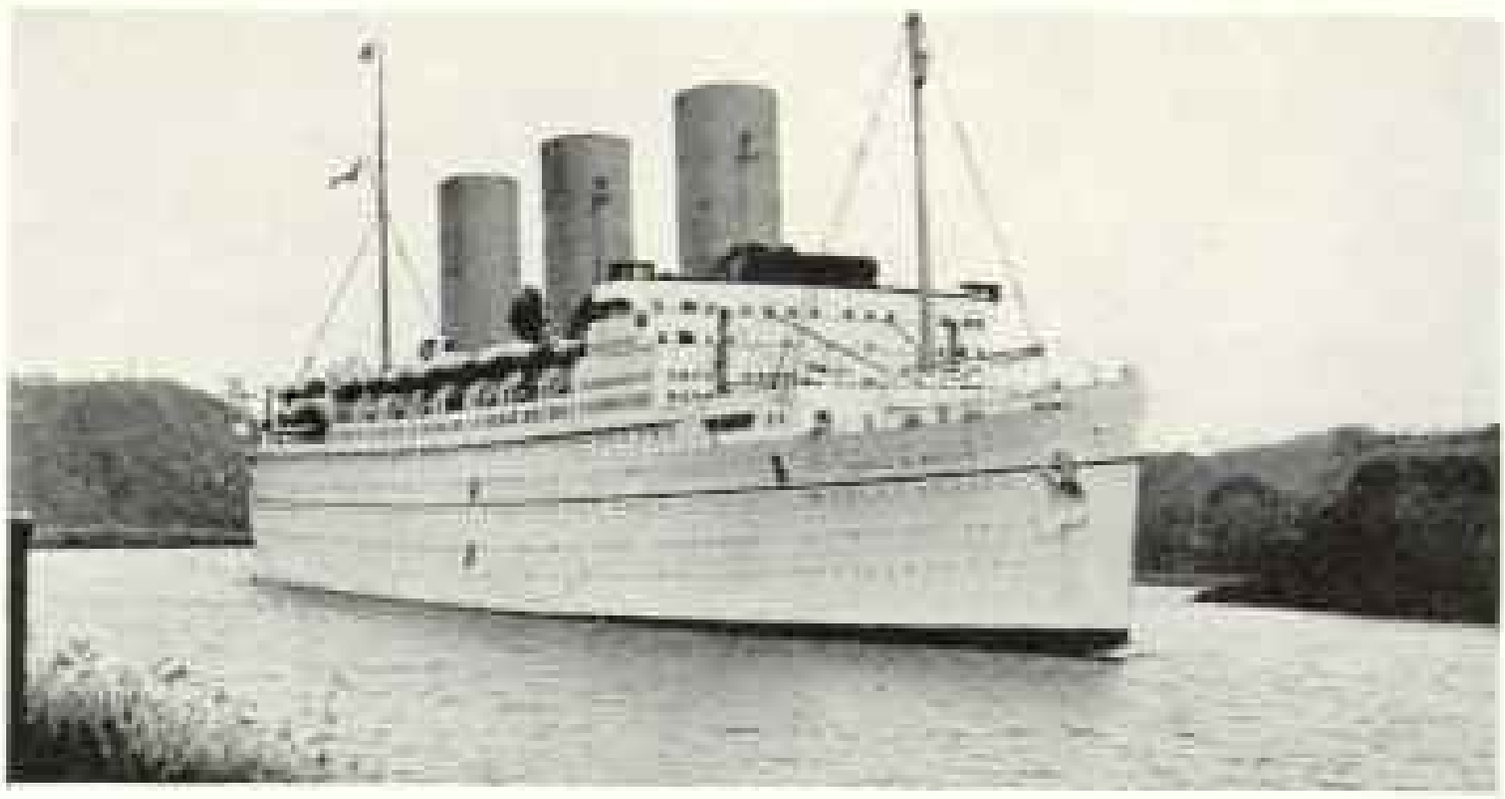
FROM NEW YORK JAN. 4, 1934



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WORLD CRUISE

CANADIAN PACIFIC

"I KNOW SOMETHING ABOUT *Machinery!*"

Interview with Stanley Somers, Aeronautical Engineer, Wright Field, Dayton, Ohio

De Luxe 4-door Sedan
$575 F.O.B. Detroit

"Better Engineering all the way through sold me on Plymouth"

"BUY a new car? That was the last thought in my mind when I flew to my new post at the Army Aeronautical Exhibit at the Century of Progress.

"But one look at the new Plymouth at the Chrysler Motors Exhibit . . . and I got ideas!

"I liked the cut of its jib, to begin with. But it was its *engineering* that got to me! The *advanced thinking* those Chrysler Motors people are putting into their cars!

"Heat-resisting valves that practically put an end to valve grinding! Self-equalizing hydraulic brakes . . . Floating Power engine mountings that cut out vibration!

"I looked at other low-priced cars, too. But Plymouth got my order!"

Any Plymouth dealer will show you 20 places where it is a finer car than competitors'. Go see it!

* * *

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NOW PRICED AS LOW AS THE LOWEST

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Hot weather aggravates the knocking evil in any car. Knock causes overheating, wastes oil, shortens car life, and runs up some of the biggest repair bills that car owners ever have to pay.

Ethyl goes to the heart of the trouble!

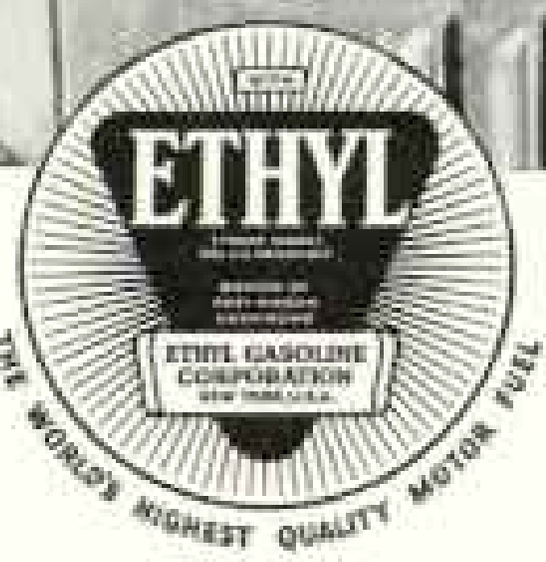
It checks overheating by *stopping* harmful knock. It turns the excess heat of knock into POWER.

That's why Ethyl Gasoline puts new life in old cars. That's why thousands say: *The next best thing to a brand new car is your present car with Ethyl!*

Stop at the Ethyl pump today. You'll put *fun* into your driving this summer.

And you'll save, in lessened repair bills alone, *more* than enough to offset the few extra pennies you spend. Ethyl Gasoline Corporation, New York City.

Ethyl contains lead. ⊙ E. G. C. 1933



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All Ethyl Gasoline is red, but not all red gasolines are genuine Ethyl. The color is for identification only and has nothing to do with performance. Look for this Ethyl emblem on the pump (or its globe).

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The all-round quality of Ethyl Gasoline is doubly tested: at the time of its mixing, and through constant inspection of samples taken from pumps.

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How much chance will you give him

in the uncertain struggle you know he'll face?

HE'LL fight to become the man you want him to be—that little son of yours. But will he find himself handicapped?

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TEXACO-ETHYL *is* FIRE-CHIEF + ETHYL

A Very Close Call

HAVE you ever escaped death by the fraction of a second when you thoughtlessly stepped almost directly into the path of a fast moving automobile? Or when you thought you were careful in crossing a street, has a car ever whirled around a corner, missing you by inches? That time you were lucky.

In this country, forty pedestrians are killed every day by moving cars and eight hundred are injured—some of them maimed for life. Thirty-five pedestrian accidents occur every hour—that is the present daily average.

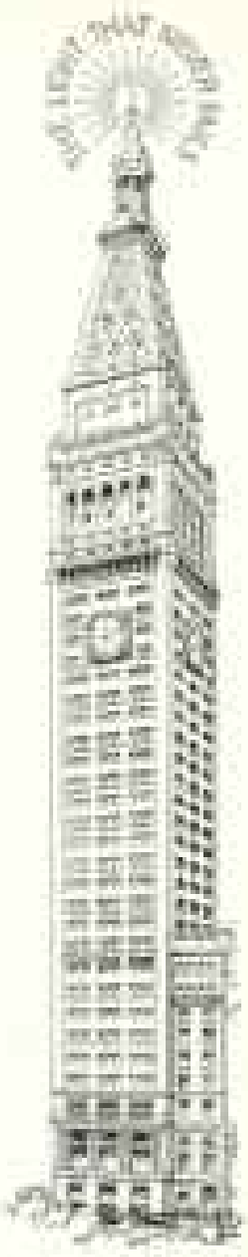
Reckless drivers are directly responsible for part of this daily tragedy, but the majority of such accidents are the result of carelessness or thoughtlessness of pedestrians.

Although the safety training of children by some schools has helped to prevent many accidents, about ten children are still being killed every day. Even effective signals and alert traffic officers at crowded street corners are powerless to help the persons who step out from behind a parked car.

Your safety and the safety of every member of your family, when crossing a street or walking on a highway, depends on the development of a fixed habit which must become second nature: Make certain that the road is clear before you take a step.

Will you uphold the teachers who are training the children to watch for the "Go" and "Stop" signals—and will you obey traffic regulations provided for your own safety?

Send for the Metropolitan's booklet "The Safe Walker's Memo Book." It tells of the constant dangers which threaten those on foot—how you and yours can be safe walkers. Address Booklet Department 833-N.



ARE YOU A SAFE WALKER?

To how many of these questions can you answer NO?

Do you:	NO	YES
1. Step out carelessly from behind parked cars or obstructions?	___	___
2. Try to weave through traffic?	___	___
3. Cross streets diagonally?	___	___
4. Get off and on vehicles in moving traffic?	___	___
5. Cross streets without observing traffic?	___	___
6. Cross at intersections against the light?	___	___
7. Stand in the street?	___	___
8. Allow your child to play in the streets?	___	___
9. Walk with instead of against traffic on the road or highway?	___	___
10. Fail to use particular care at night?	___	___

METROPOLITAN LIFE INSURANCE COMPANY

FREDERICK H. ECKER, PRESIDENT — ONE MADISON AVE., NEW YORK, N. Y.

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GUM-DIPPED TIRES MADE
At A Century of Progress

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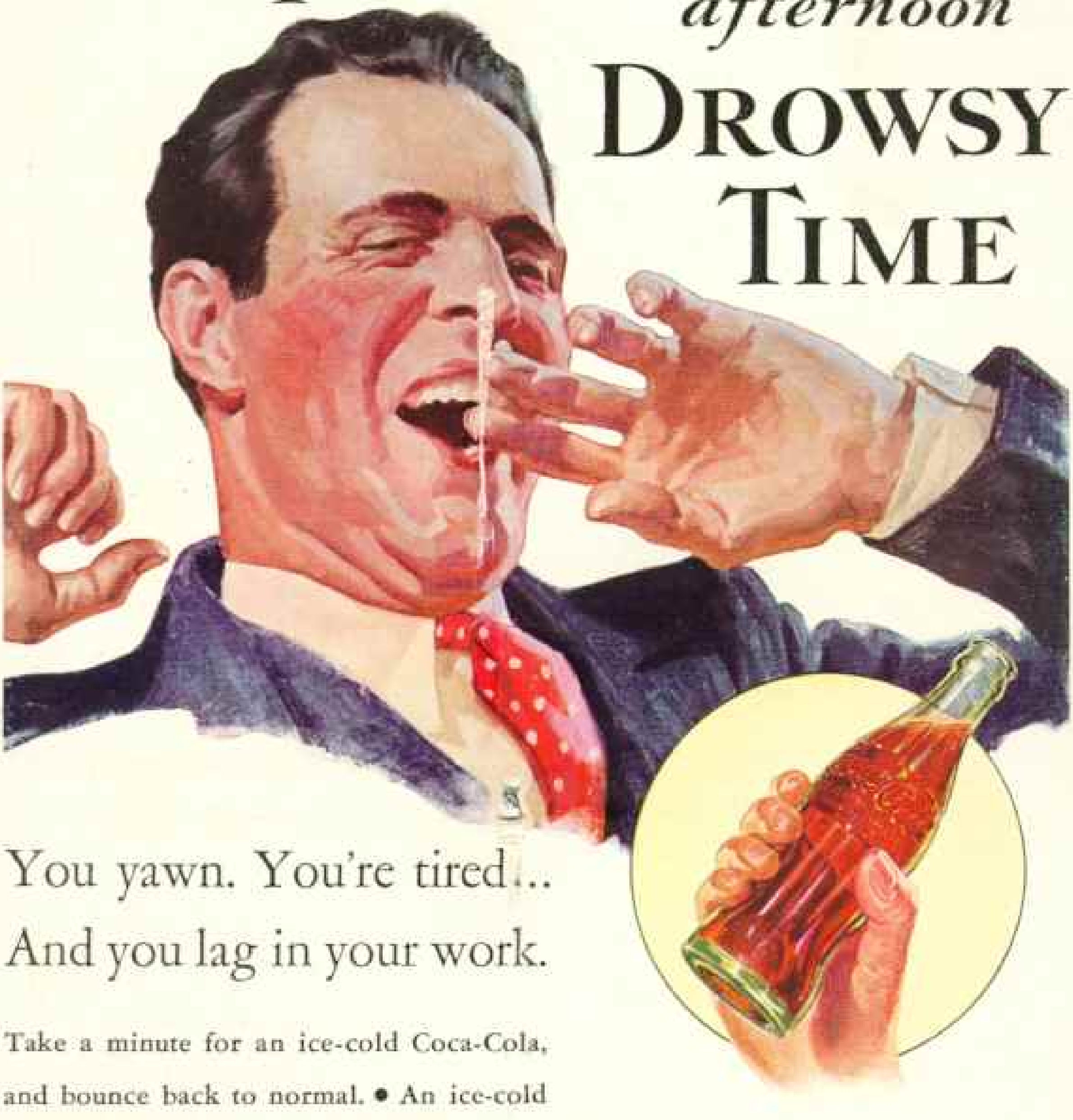
Firestone

TIRES • TUBES • BATTERIES
SPARK PLUGS • BRAKE LINING
RIMS • ACCESSORIES

Snap out *of afternoon* DROWSY TIME



You yawn. You're tired... And you lag in your work.

Take a minute for an ice-cold Coca-Cola, and bounce back to normal. • An ice-cold Coca-Cola is more than just a drink. It's a very particular kind of drink—combining those pleasant wholesome substances which foremost scientists say do most in restoring you to your normal self. Really delicious, it invites a pause—*the pause that refreshes.*

Refresh yourself
Bounce back to normal

Brighten the cold meal with good hot soup!

Every cold meal should include one-hot-dish — for your greater enjoyment and for health. The sparkling, invigorating flavor of Campbell's Tomato Soup awakens the appetite, sharpens the sense of taste, makes all the cold foods more appealing by way of contrast. And digestion is greatly benefited. Let Campbell's Tomato Soup improve many a meal for you this summer!

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RED-AND-WHITE LABEL

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Bean	Mutton
Beef	Ox Tail
Bouillon	Pea
Celery	Pepper Pot
Chicken	Printanier
Chicken-Gumbo	Tomato
Clam Chowder	Tomato-Okra
Consommé	Vegetable
Julienne	Vegetable-Beef
Mock Turtle	Vermicelli-Tomato

10 cents a can

Campbells'
Tomato Soup

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To have a telephone is to hold your place in the world of people—to keep unbroken your contact with those whose help and friendship are so essential.

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The value of the telephone can be measured only by measuring the activity of the people who use it and the diversity of life itself.

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