

Semasia krygeri Rebel (Lep., Tortr.).

Morphology and biology.

By

J. G. Worm-Hansen and Sv. G. Larsson.

Historical remarks.

(by J. G. Worm-Hansen).

The species was found for the first time on September 30, 1934 by the all-round entomologist J. P. Kryger, after whom it was named. It was taken near Langtved ferry inn at Bramsnæs Vig, a locality which is situated about 7 km southeast of Holbæk, a town on Zealand. It was the conspicuous galls on *Artemisia maritima* which attracted Kryger's attention.

In a letter to the author of this chapter Kryger tells about his find. He had made an excursion to the surroundings of Bramsnæs Vig, which had only yielded poor results, and towards the evening he arrived at the small peninsula at the ferry near Langtved inn. It was about 6 p. m., the weather was misty and darkness falling, and all regular search had stopped. But Kryger is always open-eyed. On one of the numerous *Artemisia maritima* which grew on the peninsula he saw a swelling on the stalk. He seized the plant, split open the stalk and found a fat butterfly larva in the gall. Kryger rapidly collected fifty stalks with galls and at the last moment reached the bus for Roskilde.

Kryger sent the stalks with the galls to our two experts, C. S. Larsen of Faaborg, and H. P. S. Sønderup of Maribo (now Lemvig), each got 25 specimens, and Larsen, who reared some in 1935, believed at that time

that a species new to the Danish fauna, viz. *Semasia metzneriana* Tr., had been found. On June 2, 1935 Kryger again visited the peninsula near Bramsnæs Vig; he then collected a few adults, and on October 22, the same year he gathered fifty stalks for Sønderup who reared a number of adults in 1936. During this excursion Kryger also found *Semasia* galls on the Munkholm side of the inlet.

In the meantime Kryger, Sønderup and Larsen discussed the matter, and Kryger, on account of his thorough knowledge of galls, persisted in his view that the *Semasia* found must be a new species. In 1936 Larsen therefore sent four specimens of the butterfly to Professor H. Rebel of Vienna, and in *Zeitschr. Oesterreich. Ent.-Ver.*, Wien, No. 5, 1937 p. 2, Professor Rebel described the species under the name *Semasia krygeri*.

On May 30, 1937 the Entomological Society of Copenhagen made an excursion to Bramsnæs Vig with Kryger as a participant. On that occasion the author became familiar with the animal and the characteristic galls, and in June that year he reared a number of adults from the collected galls.

As I now knew the *Semasia* galls I found them on the west coast of Amager near Copenhagen, near the military shooting grounds, on May 24, 1942, but the previous year, on April 11, 1941, Kryger had himself found lots of galls at the lock dam on Amager.

Up to 1920 Kryger had done much collecting work on Amager; he always had his attention focussed on the gall formations of plants, and he is nearly certain that *Semasia krygeri* did not occur on Amager at that time. Later on the late barrister Gudmann, who was an expert at capture and rearing of microlepidoptera, had done much collecting on the west coast of Amager, also quite close to the sea shore, and he never mentioned the gall on *Artemisia maritima*. Up to 1940 Kryger also explored other parts of the coast of Amager, e. g. the

south coast off Store Magleby; he found no galls there ("with guarantee" as Kryger writes in his letter to me), but when, on his request, I examined the locality on May 11, 1944 near Store Magleby I found many galls.

Thus much seems to indicate that the animal immigrated to Amager only in recent years, and that it has spread more and more in the last few years. Kryger found his galls near the lock gate. In 1944 I found galls, often in very large numbers, in all the neighbouring localities where *Artemisia maritima* is abundant.

In 1943 and 1944 I made a series of excursions to Amager, partly to gain some knowledge of the biology of the animal, partly to procure some specimens for the description of egg, larva and pupa. Also on the Zealand side of Kalvebodstrand off Amager I have looked for *Semasia krygeri*, but without result, because the coast there is swampy and muddy without a suitable soil for *Artemisia maritima*.

Morphology.

(by Sv. G. Larsson).

The **egg** is shaped like a small pitcher; it has a faint mother-of-pearl lustre and is smooth with a coarse sculpture; in the flatly rounded "lid" and on top of the sides there are flat, smooth depressions, while the sculpture farther downwards becomes more elongated and faint. At the base there are a number of unevennesses, irregularly hook-shaped processes by means of which it attaches itself to the hairy host plant; the egg does not however always stand in an upright position, just as often it occurs in a more or less horizontal position. The egg is about one third mm long and nearly half as large in diameter; thus it is comparatively large in relation to the size of the butterfly.

The mature larva. The yellow-white larva is fairly powerful and robust, five to six times as long as broad.

The sides are nearly parallel from the second thoracic segment to the fifth abdominal segment. The prothorax is of nearly the same breadth posteriorly, but tapers rather strongly anteriorly towards the fairly small head, which is about half as broad as the body where it is broadest; posteriorly the body tapers gradually towards the tenth abdominal segment, which is almost of the same breadth as the head. The body is only slightly broader than high.

Apart from the strongly chitinized head the larva is only faintly chitinized. On the dorsal side there is a fairly strong sclerite on the prothorax and on the tenth abdominal segment, while the other sclerites, which serve as basis for one or a few small setae, are but very small and arranged several together on each segment; they are often very difficult to see. On the sides the delicate chitinous ring of the spiracles is the only thing which is fairly strongly chitinized, while on the ventral side only legs and crochets are conspicuous. The setae are very few in numbers.

Length 10-11 mm, thickness about $1\frac{3}{4}$ mm.

Head. The head capsule is very dark and strongly chitinized; it is distinctly broad across ($4 : 2\frac{1}{2}$) with evenly rounded sides without sharp corners and faintly compressed. The epicranial parts are completely separated from each other. On the dorsal side they are separated by the frons which reaches nearly right back to the occipital foramen, so that the epicranial suture becomes exceedingly short. On the ventral and lateral side the epicranial parts together with the two parts of the hypostome form the frame round the mouth area, except the narrow central part, which is entirely soft-skinned. The frontal sutures are straight and distinct; they begin near the corners of the upper lip and meet just in front of the occipital foramen. The frons thus becomes an equilateral triangle which is almost twice as long as broad.

An independent epistoma is not found, but may have coalesced with the frons. Anteriorly the labrum is of the same breadth as the frons, to which it is attached by a very large and soft intermediate skin. The labrum is more than twice as broad as long and tapers anteriorly; in the anterior border which continues into the lateral borders without sharp angles it has a large even and rather flat curve.

In each ocellar group there are five ocelli which are situated in a semicircle which is open posteriorly and has a seta in the centre; they are placed anteriorly on the sides of the head, close behind the antennal bases. The individual ocelli are well developed and almost equally large, and all of them are provided with well developed lenses.

The antennae are short, but fairly powerful; they are rather movable and can be withdrawn in part and they consist of three joints. The first joint is cone-shaped, much broader at the base than at the tip; its chitinization is both relatively smaller and relatively much more faint than on the other joints, the cuticle being almost membraneous; it is slightly shorter than broad at the tip. The second joint is one and a half times as long as broad and slightly thicker at the tip than at the base; it is smooth and bears at its tip, besides the third joint, two strong setae of which the one is long, more than twice as long as the carrying joint. The third joint is quite small, being about one and a half times as long as broad, and shorter than the second joint is broad; at its tip it bears several powerful setae of which one is at least as long as the joint.

The mandibles are short and powerful and of the spoon-shaped type. Their anterior border is running obliquely from the anterior border of the labrum and some distance forwards, so that the mandibles complete the protection of the ventral mouth parts from the ante-

rior and dorsal sides which is partly given by the upper lip. The cutting edge of the mandibles bears a row of teeth, uppermost four large ones and below some smaller, and in the depression of the spoon there are prominent sutures which correspond to the placing of the teeth. The mandibles form the median side in the triangular soft-skinned area into which the antennae are imbedded.

The ventral mouth parts has coalesced in a considerable degree, so that the labium is only free in its most anterior part. On the maxillae the cardo is well defined and very strongly chitinized, far more strongly than any of the other portions of this mouth part. The stipes is large and fleshy, it is faintly chitinized, so that the chitinization falls into several small portions, but there is no question of any articulation between these; along the inner border there is a large chitinization which is articulated with the cardo; on the outer side there is anteriorly a semicircle and posteriorly a rounded angle which is more strongly chitinized. The masticatory lobe, which is short, thick, and soft-skinned, is almost naked, carrying only a few setae at the tip beside two unsegmented papillae, each at the tip provided with a fairly distinct but rather short sensory cone. Lateral to the masticatory lobe a papilla (the palp) is situated which is imbedded into two movable chitinous semicircles (the short palpifer); it consists of two joints of which the outer one is considerably more slender than the inner; the first joint is about one and a half times as long as thick and a little longer than the terminal joint which at its tip carries a small sensory field.

The portion between the maxillae, which are composed of the labium and the hypopharynx, is on the whole soft-skinned, only anteriorly a more strong chitinization being present. This foremost portion is in the first place the prementum from which an anterior section carrying the labial palps and the spinneret is sepa-

rated anteriorly by a suture. In the soft-skinned area behind the prementum several weak and ill-defined sclerites are found of which the posterior median one presumably is the submentum, and almost midway on it two strong setae are placed. It looks as if these two setae designate the limit between the submentum placed posteriorly and the mentum situated anteriorly; such interpretation would correspond to the normal situation of the setae in the anterior border of the submentum. The labial palps are unsegmented but rather long and very slender; at the tip of them a very long seta is situated. The spinneret is strong and more than twice as long as the labial palps; it is curved faintly downwards. In the resting position and certainly also when the animal feeds, the whole firmly chitinized part of the labium is bent downwards and backwards along the mentum and the submentum, where a quite flat elongate pit shows the normal bed of the spinneret; when the head, as is often the case, is partly withdrawn into the prothorax, whereby most of the ventral side which is turned obliquely backwards, is concealed, the spinning-apparatus will as a whole be very well protected.

As the different body segments are built according to the same plan, the fourth abdominal segment will be used as an example, and the exceptions to this will be mentioned below. The individual segments are, primarily on account of the muscle attachments, divided into several pads by grooves in the surface: two almost equally large dorsal pads, a dorso-lateral pad, a lateral pad, a ventro-lateral pad and a single ventral pad, and to each of these pads definite very small and likewise very weak setigerous sclerites are attached. On the foremost dorsal pad there are one pair of plates, each of them bearing a single seta; their mutual distance is approximately four times as large as the breadth of the individual plate. On the hindmost dorsal pad there is found

one pair of plates too, each of them carrying a seta and situated at a slightly greater mutual distance than the two preceding ones. On the dorsolateral pad, which is only faintly delimited upwards, a single plate is found which also bears only a single seta; this plate is of the same size as the preceding ones. It is on this pad the circular spiracle is situated, the plate above and the spiracle below. Both on the lateral and the ventro-lateral pads, the latter being only faintly delimited downwards, there is a plate with one seta; on the preceding segments there are however two setae on the plate of the lateral pad. The ventral pad covers the greater part of the ventral side of the segment and has four sclerites, two on either side of the midline; the outer plate which serves as attachment for three large and some small setae is placed laterally on the pad, and on the segments provided with prolegs they are situated on the outer side of the basal parts of the prolegs; the median plate, on which only a single seta is situated, is placed very close to the midline and on the segments with prolegs it is found on the inner side of the basal portion of the prolegs. The typical body segment thus has on either side of the midline altogether seven small sclerites, which are of almost equally size, each carrying a single or some few setae.

Deviating from this description is in the first place the prothorax on which the individual dorsal pads are not recognizable but covered by a common sclerite which is much more vigorously coloured than the rest of the sclerites; on this sclerite are placed the setae which correspond to those of the above mentioned sclerites on the dorsal and dorso-lateral pads. The sclerite is strongest on a cross band extending from one side to the other, being considerably weaker anteriorly and posteriorly; in the midline it is broadly interrupted along the moulting suture. This dorsal sclerite which covers

the dorsal pads and the greater part of the dorso-lateral pads reaches right to the lateral pads, but does not embrace the spiracles which are displaced backwards together with the rest of the dorso-lateral pad, thus being placed behind the lateral pad. Also on the dorsal side of the meso- and metathorax there are deviations from the conditions on the intermediate abdominal segments; there are for instance not two but three dorsal pads, there being, in front of the two usual pads, a smaller, more or less distinctly transversely divided pad which completely lacks sclerites. There are no sclerites on the hindmost dorsal pad, but two pairs on the intermediate one, one pair outside the other. Finally, the dorsal plates and the dorso-lateral plates bear on the thoracic segments not one but two setae each. The ventro-lateral pad of these segments is situated higher upon the sides of the larva and lacks the plate, whereas the plates (two on the pro- and mesothorax and only one on the metathorax) which are situated just outside the thoracic legs are supposed to be the outer plates of the ventral pad. Also the last segments, the ninth and tenth segments of the abdomen, are deviating, both lacking spiracles. Most different is however the tenth abdominal segment which has the dorsal plates fused into a single unpaired brownish plate with lighter and more faintly chitinized parts. Posteriorly this segment ends in a rounded tip projecting slightly the anus and the hindmost prolegs.

The thoracic legs are composed of the usual joints: the coxa, the trochanter, the femur, the tibia, the tarsus and the unguis. The coxa is almost like a pad, however with a rather strong chitinization, which like a semi-circle embraces the basal part of the leg on the inner side; the coxa is, though only faintly chitinized, by far the best developed joint. The trochanter is only discernible as a quite narrow, but powerful chitinous list, a

semi-circle, on the inner side of the leg, where it is situated close to the femur. It holds good of both the femur and the tibia that their sclerites are not tubular, as is usually the case, but they are open on the ventral side. The femur is distinctly broad across, while the tibia is somewhat longer than thick. The tarsus consists only of a single segment, with tubular sclerite; along its upper border it is from one and a half to two times as long as high. The ungulus is curved and has a tubercle on the ventral side close to the base; it is about half as long as the tarsus along the upper side.

The prolegs are placed, like the thoracic legs, on the ventral pads. The five usual pairs are present, being rather well developed without being conspicuous by any special shape, size or other peculiarity; they are all of them provided with crochets. On the four foremost pairs of prolegs, which are almost equally large, the crochets are arranged uniordinally in a single circle of hooks consisting of almost equally large and on the whole uniform hooks, totally about 22-23. These circles are oval across or rather egg-shaped, being somewhat broader laterally than medially. The individual hooks are built according to the ordinary type (fig. 18-19, p.188). On the anal feet the crochets are of the same type, but here they are arranged in a single row, which is semicircular and cover the anterior border of the prolegs from one side to the other; most of the about 13 crochets of the anal feet are equally large and of the same size as those on the other prolegs, but the outer ones, both those on the inner and the outer sides, are somewhat smaller.

The pupa. The brown colour of the 7-8 mm long pupa is rather light, particularly on the abdomen; its shape is that of most butterflies, being fairly short and strongly built, a quite ordinary object pupa without any outgrowths. From the second to the last abdominal segment it is furnished with two rows of spines on the dor-

sal side of each segment, the anterior extending from one spiracle to the other, and the posterior near the posterior border of the segments. On the second abdominal segment both rows are very faint, the foremost sometimes nearly absent or at any rate very short, numbering at most very few spines; there are far more spines in the hindmost row. On the third segment the spines in the foremost row, which is only slightly shorter than the hindmost row. On the fourth to seventh abdominal segments the foremost row is provided not only with the most powerful spines but this row is also much longer than the hindmost row. On the eight to the tenth segments the hindmost row is completely lacking, while the spines in the foremost row become stronger posteriorly, though decreasing in number. On the hindmost segment there are only three but very powerful spines left. The spines are more or less conspicuously shaped as rose spines; they are directed somewhat backwards except on the three last segments. On the last segment but two they are directed almost straight out, on the last segment but one they are bent faintly forwards, while the very big spines on the terminal segment are curved rather strongly forwards.

Imago. As far as the imago is concerned the reader is in the first place referred to Rebel's original description which we take the liberty to reproduce here:

Fühler nur bis $\frac{2}{5}$ der Vorderrandslänge der Vfl reichend, beim ♂ etwas verdickt, mit sehr gering abstehenden Gliederenden, weisslich grau. Die Augen gross, schwarz. Die weissen, buschig beschuppten Palpen, von $2\frac{1}{2}$ Augendurchmesserlänge, stehen gerade vor. Sie sind aussen etwas grau gemischt, ihr Endglied und der Rüssel sind verborgen. Kopf und Thorax weiss beschuppt, die Schulterdecken zuweilen etwas grau gemischt. Die kurzen Beine durchaus weiss, die Hinterschienen anliegend beschuppt, die Tarsen namentlich der Vorderbeine

schwarzlich gefläckt. Der weisse Hinterleib konisch, beim ♂ mit sehr kurzem Afterbusch, beim ♀ spitz endigend, mit kurz hervorstehender Legeröhre.

Die Flügel sehr gestrect, der Vorderrand der Vfl schwach geschwungen, beim ♂ ganz ohne Umschlag, der Saum steil, ober dem Innenwinkel etwas ausgebaucht. Die Hfl etwas breiter als die Vfl mit bauchigem Saum und stumpfer Spitze. Die Grundfarbe aller Flügel ist rein Weiss, jene der Vfl aber durch schwärzlich graue Zeichnung stark eingeschränkt. Letztere besteht aus einer getheilten, in der Form abändernden Innenrandsmakel vor $\frac{1}{2}$ der Flügellänge, deren beiden Teile basalwärts, in Form unterbrochener schwärzlicher Längsstreifen, ausgezogen sind. Sie durchsetzt kostalwärts noch die Mittelzelle. Nach ihr folgt ein grosser rein weisser schildförmiger Fleck der Grundfarbe, dessen Gestalt ebenfalls wechselt. Er wird nach aussen durch zwei getheilte schwärzliche längsstreifenartige Flecke begrenzt, die eine Fortsetzung der unterbrochenen Basalzeichnung bilden und bis an den kleinen runden, reinweissen Spiegelfleck im Saumfeld reichen. Dieser weist zwei kurze schwärzliche Längsstreife auf, deren oberen zuweilen in ein oder zwei Punkte reduziert erscheint. Am Vorderrand liegt von $\frac{1}{2}$ angefangen eine wechselnde Anzahl kurzer Streiche, deren vier letzte nach unten breit rein weiss gesäumt erscheinen. Diese weisse Säume vereinigen sich zumeist und bilden die obere Begrenzung des grauen Saumfeldes, das sich auch um den Spiegel herumzieht. Die grauen Fransen sind am Innenwinkel weiss.

Sehr charakteristisch sind die glänzenden weissen Hinterflügel gezeichnet, indem sie eine am Innenrande sehr schmal beginnende, schwärzlich graue Saumbinde aufweisen, die sich in der Flügelspitze stark erweitert und oft auch unterhalb des Radialastes eine spitze Fortsetzung basalwärts zeigt. Die Fransen der Hfl sind seiden-glänzend rein weiss.

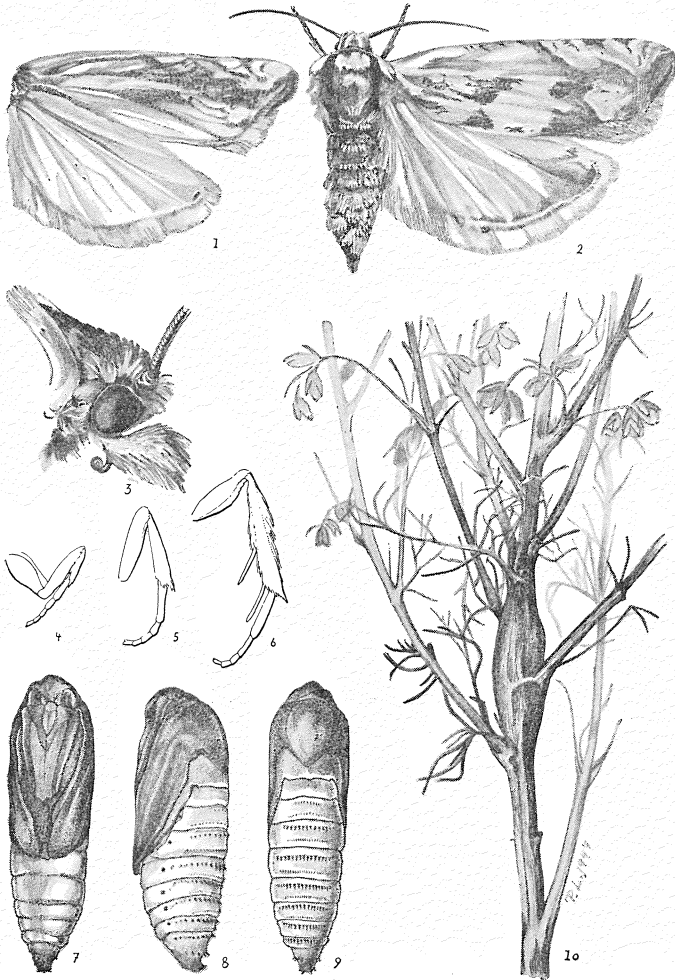
Die Unterseite der Vfl ist grau mit weissen, schwarz gezeichneten Spiegelflecken und solchen Vorderrandshäkchen. Jene der Hfl ist einfarbig weiss, zuweilen mit Spuren der dunklen Saumbinde der Oberseite. Vflänge 7,5—8, Exp. 16—17 mm.

Von der genetisch gewiss sehr nahestehenden *S. candidulana* Nolck. durch gedrungeneren Gestalt, rein weisse Flügelgrundfarbe, viel reichere schwarzgraue Zeichnung der Vfl und die so charakteristische schwärzliche Saumbande der bei *candidulana* einfarbig grauen Hfl leicht zu unterscheiden.

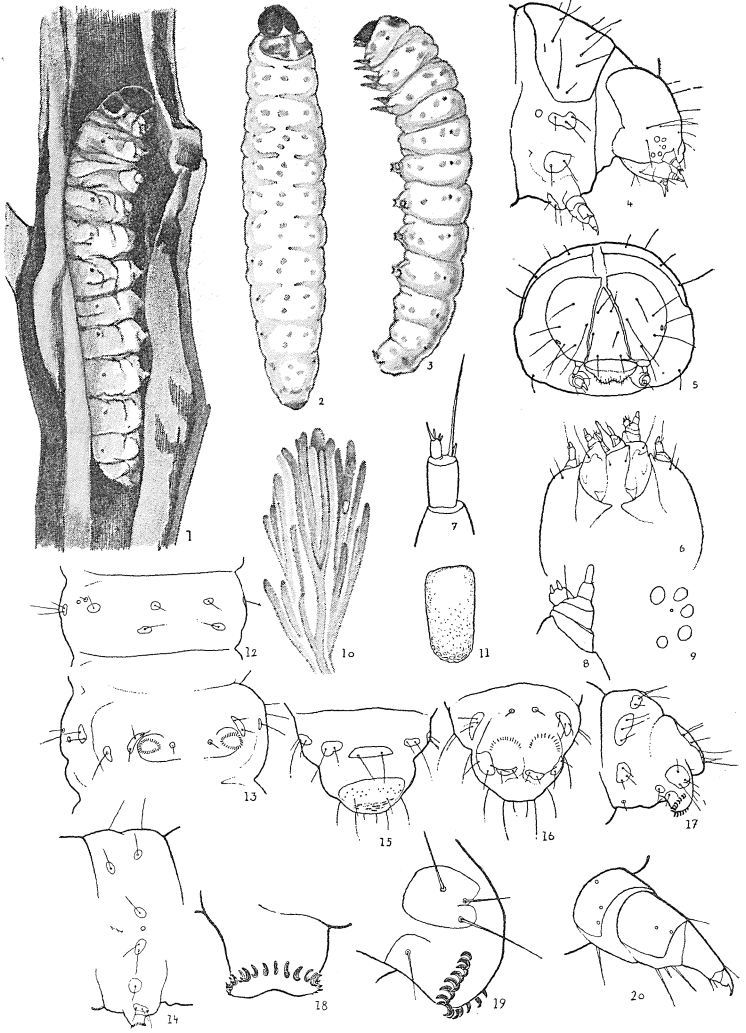
To this description should be added that Rebel's type specimens as a whole are a little lighter than the average of the about fifty specimens kept in the collections of the Zoological Museum of Copenhagen.

A feature which seems to have escaped Rebel's attention is the shape of hind wing. It completely lacks the outer posterior angle, being evenly curved from the point to the inner posterior angle. Only very few specimens have a faint indication of an outer posterior angle. This feature is very remarkable since among the Danish species it only occurs in the easily distinguishable *Semasia hypericana* Hb.; in all the other species, and particularly in *Semasia candidulana* Nolck., which bears a strong resemblance to *Semasia krygeri*, there are in nearly all the individuals even very conspicuous posterior angles.

The male genitalia consist of the chitinous ring of the ninth abdominal segment and different processes upon it. Dorsally, the uncus is inconsiderable, consisting only of a pair of short, distinctly separated branches, and on the top, of a pair of flat protuberances. A scaphium, which in many Lepidoptera is developed beneath the uncus, is lacking. Upon the ventral part of the chitinous ring the saccus is well developed, the posterior angle being rather prominent (about 100°), but somewhat



Semasia krygeri Rebel. Imago. 1. wings from beneath; 2. wings from above; 3. head from the right side; 4. fore leg; 5. middle leg; 6. hind leg; 7. pupa from beneath; 8. pupa from the left side; 9. pupa from above; 10. host plant (*Artemisia maritima*) with the gall.



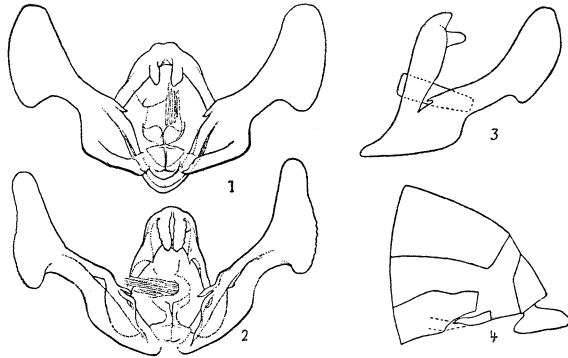
rounded. The large valves or claspers are fixed ventrolaterally upon the segmental ring. Together they form a posterior chitinous ring which, however, when in use may open dorsally. The arms of the claspers are rather slender and well defined, the costa being very distinct. The inner surface of the claspers is closely covered with long and rather stiff hairs, most of them directed upwards and slightly inclined forwards. The aedeagus is rather short; it contains several cornuti.

The species *Semasia candidulana* Nolck. is, as previously mentioned, very closely related to *Semasia krygeri* Rebel; the differences, both biological and morphological, are, however, evident. Such is also the case with the male genitalia. In *S. candidulana* the following characteristics may be mentioned for comparison with the description and the figures of *S. krygeri*: The two dorsal processes are placed nearer the top of the uncus, touching each other almost along their whole length, and the flat protuberances have fused into a single one. The posterior angle of the saccus is much less prominent (about 135°). The distal part of the claspers is much more slender.

In the female the genitalia have two openings, as in nearly all other Lepidoptera, the original one at the apex of the body and the secondary one in the eighth abdominal sternum. The apical opening, through which

Semasia krygeri Rebel. 1. larva in the gall; 2. larva from above; 3. larva from the left side; 4. head and prothorax of larva from the right side; 5. head from before; 6. head from beneath; 7. right antenna from above; 8. left maxilla from beneath; 9. ocelli from the right side; 10. egg upon the Artemisia leaves; 11. egg; 12. fourth abdominal segment of the larva from above; 13. fourth abdominal segment from beneath; 14. fourth abdominal segment from the right side; 15. tip of abdomen from above; 16. tip of abdomen from beneath; 17. tip of abdomen from the left side; 18. hindmost right proleg from before; 19. hindmost left proleg from the left side; 20. thoracic leg.

the egg-laying takes place, is surrounded by two smaller valves and by the almost ringshaped ninth abdominal tergum. This is the part of the female abdomen, which is enclosed by the claspers during the copulation. The opening of the eighth abdominal sternum, the copulatory opening, has a direction, as if it has been pricked from behind, in that way having become the best shape for the working aedeagus. Even when newly hatched, the female contains fully developed eggs.



Genitalia of *Semasia*. 1. the male genitalia of *S. krygeri*, prepared in the common way; 2. the same of *S. candidulana*; 3. the male genitalia of *S. krygeri*, unprepared and seen from the left side; 4. tip of abdomen of the female *S. krygeri* from the left side.

Biology

(by J. G. Worm-Hansen).

The butterfly flies in June. All my hatchings commenced and ended in June, in 1943 from June 8, to 14, and in 1944 from June 5, to 21. It should however be noted that in 1944 I reared two individuals on May 13, and 30, respectively, but the galls for these has been placed in heated room since April 8. In the open I have taken the first imago on June 1, most frequently from June 9, to 12, and latest on July 7. Now and then a few parasitic wasps appeared from the galls during hatching.

As far as the hatched animals were concerned egg laying occurred at the end of June. I let the emerged butterflies live the whole month in big glass vessels, in which, together with the stems with galls, I placed fresh *Artemisia maritima* in small water dishes. The butterflies flew rather briskly about in the glasses, but I did not succeed in observing any pair in copulation; pairing may have taken place during the night. The butterflies died in the course of a month, and on examination I found a number of eggs scattered, singly, on the stems and leaves of the *Artemisia*.

The butterflies were not fed in captivity and nevertheless they were able to keep alive for several weeks, copulate and deposit eggs. Thus both sexes have been able to propagate without any supply of nourishment from outside, solely on the basis of the substance which might be left from the feeding stage of the larval life the preceding summer. This is in full agreement with the very short proboscis which a priori seems to exclude this species as carrier of pollen. That such a comparatively small number of eggs was obtained in comparison with the number of butterflies is presumably due not to lack of food but to the absence of humidity; the air has been too dry during the captivity, a factor which also seems to have had an unfortunate influence on the eggs but probably also on the young larvae; no drops of water were found on the leaves corresponding to the morning dew. There is no reason to believe that the butterflies in nature absorb any special food, but no doubt they suck some water from the leaves of plants, it be either dew or rain drops.

How many times the individual female or male generally copulates has not been observed, but the females certainly pair only once. It is also unknown how many eggs are deposited, but they are laid singly on leaves or sometimes on the stem of the host plant, on which

they are fastened to the woolly hairs of the young shoots.

The development of the egg takes only a few days, hardly more than a week.

As soon as the larvae have emerged from the eggs they seek to the stem of the shoot, but generally near the tip of the shoot, where the tissue is softest and the growth most active. They generally prefer places near a sheath, hiding themselves underneath. Here they bore into the inner parts of the stem where they make a short burrow. This process has not been observed, but necessarily it takes place some eight or ten days after egg-laying, judging from the observations made. The rest of the larval life is now spent in the burrow made in the young shoot.

During the whole month of July and the beginning of August I searched for fresh galls on the *Artemisia* on Amager, but not until August 6, they were so advanced in development as to be recognizable. On a few plants a faint curling up of the top and below a faint dilatation of the stem were slightly indicated; this young gall contained a tiny larva. A closer examination revealed that this faint formation of gall with a larva was present on numerous plants.

In the course of the last summer months both larva and gall attain full size. It is seen only exceptionally that a larva has bored itself out of the burrow once made and again bored into the stem of the shoot. As a rule there is only a single larva in each shoot, irrespective of how many eggs might have been deposited on it; two larvae may however be found occasionally, but always each in its own gall and most often of very different size. It seems however as if one of these larvae nearly always perishes (presumably the younger) so that generally never more than one butterfly is reared from each shoot.

The presence of the larva has a decided influence

on the further growth of the shoot. The growth in length often stops completely or is considerably lowered; how much it is lowered is presumably dependent on the maturity of the shoot and the place in which the attack was made; the older the shoot is at the time of the attack and the farther from the point of the shoot it sets in, the smaller will be the effect and the smaller the swelling. In the place where the burrow, which is often 2-3 cm long and often much widened, is found the shoot swells gall-like; the degree of swelling depends on the age and susceptibility of the particular part of the stem. It is not uncommon that the part of the shoot above the gall has completely withered away, but this is however not always the case.

There are most frequently two holes to the interior of the gall besides more or less accidental perforations which often only indirectly are connected with the larval attack but are due to weak points in the wall of the gall; one hole is at the bottom and one at the top of the burrow. Of these holes the bottom hole is presumably the original entrance hole, while the top hole, which is generally somewhat larger, and which at any rate is widened rather considerably before pupation, is of a later date and often arisen by the falling off of the top of the shoot. It is through these holes that the excrements during the larval life are thrown out of the gall, and it is just by means of these heaps of excrements which are kept together and fastened to the edges of the holes by spun threads that the galls or rather the larval burrows are best recognized at the early stage when the gall has not become visibly dilated. The fact that both holes are used during the cleaning shows that the larva does not occupy any definite position in the burrow but turns its head now upwards, now downwards; this also agrees with the condition examined, as in about half the galls opened the

larva turned its head upwards, and in the rest downwards. Conditions are however quite different when the time of pupation approaches, then all the larvae turn their heads upwards.

How great the mortality is among the small larvae cannot be said, but it is presumed to be rather considerable, simply because normally only a single butterfly is developed in each shoot. Among the larvae which are big enough to show themselves by means of galls the mortality is about 25 per cent judging from the number of empty galls in September; this at any rate was the case in the summer of 1943 when the present investigations took place. The mortality is presumably subject to rather considerable fluctuations from one year to another. During hibernation the mortality at any rate normally does not increase in any noteworthy degree, since at that time, towards the end of May, when pupation is to begin, half of the galls are found to be empty. The cause of death may be very different; very often the gall is found to be cut to pieces in such way that it must be taken for granted that the larva was taken by a bird, but almost quite as often it looks as if the larva has died from fungus diseases, and in some cases the larva or pupa of the parasitic wasp *Pimpla nigricaposa* Thoms. is found in the gall.

When in the autumn the larvae have stopped feeding they do not absorb more nourishment, and in spring they would not with their biology be able to press more food out of the dry *Artemisia* stems. In this period they lie fairly quiet awaiting further development. In the last week of May they pupate in the galls. At that time the cavity is lined with a thin, open layer of spun threads, and the dilated top hole is also covered with a quite loose web of excrement heaps. As said above the pupa has the head turned upwards so that the old larval skin can always be found at the bottom of the

gall. Some ten days after pupation the young imago emerges. Just before emergence the pupa, by means of its dorsal spines, advances through the gall and out of the upper hole where it remains with only the posterior part inside the burrow, so much as is necessary in order that the large spines in the tip of the abdomen can give the animal sufficient foothold for the exertions involved by the bursting of the pupal skin and subsequent unfolding of the imago. The pupal skin remains at the top of the gall until thrown off by wind and weather. As far as most of the individuals are concerned emergence takes place in the first half of June, at any rate here in Denmark.

From the above collectors may be able to gather different practical hints, and some more will be added below. As said above the butterfly spends most of its life among the dense foliage of *Artemisia*, for which reason their scales are soon rubbed off and they are not very beautiful. Rearing is therefore to be recommended, and it can easily be carried through. As hibernation of the galls is rather difficult (it is best done in the open) it must be recommended to collect the galls in spring and as late as possible in May. Care should be taken not to damage the galls; it is true that this does not injure the larvae, they are able to lie for a long period of time without protection, but they cannot get through the time of pupation. The pupae will also die if they are not sufficiently covered and protected by the walls of the gall, as they will be desiccated, a feature which is due to the comparatively thin pupal skin as compared with the skin of pupae which normally develop lying free in the soil.