Fig. 11. *Acineta tuberosa*, Ehr., embryo of, showing, in series, the changes which it undergoes from the active state on its exit from the parent, to its passive, tentaculated, and spherical form: *a*, active state on issuing from the parent, when it is provided with a circlet of vibratile cilia; *b*, its globular form, assumed on becoming comparatively passive and stationary, $\frac{1}{1350}$th of an inch in diameter, the cilia passive and curved from the centripetal force occasioned by the rotatory motion which they originally communicated to the young *Acineta* in its active state; *c*, the cilia regaining their straightness, and becoming shorter; *d*, the cilia disappearing, and short tentacles projected; *e*, the cilia gone and the tentacles increased in number and elongated. India, fresh water.

Fig. 12. *Collodictyon triciliatum*, n. sp. Length $\frac{1}{771}$st of an inch: *a*, posterior (?) view, showing bifid extremity, three cilia, central line and nucleus, cellular structure and granules; *b*, lateral view; *c*, presenting a digestive space containing an incepted *Protococcus* in the 8-cell division; *d*, ditto containing a *Crumenula texta* nearly as large as itself; *e*, outline of another but common form of this Rhizopod; *f*, ditto of a globular form; *g*, one enclosing the central portion of a filament of *Oscillatoria*, while the two ends are outside the animalcule; *h*, length on the same scale as the Actinophryans; *i*, length on the same scale as that of the testaceous Rhizopoda, figs. 13 *d* and 14 *g*. India, fresh water.

Fig. 13. *Euglypha spinosa*, n. sp.; specimen $\frac{1}{171}$st of an inch long and $\frac{1}{285}$th of an inch broad; animal retracted within a diaphragm, and passive: *a*, view of broad side of test; *a'*, ditto of narrow side, or lateral view; *b*, scales on test; *c c c c*, moveable spines on fixed tubercles; *c'*, more magnified view of the spine; *d*, dotted outline of test on a scale of $\frac{1}{6}$th to $\frac{1}{830}$th of an inch, for comparison with other figures of testaceous Rhizopoda, *l. c.*; *e*, diaphragm; *f*, portion of sarcode containing fragments of food; *g*, ditto charged with granules; *h*, nucleus. England, fresh water.

Fig. 14. *Euglypha globosa*, n. sp.; specimens $\frac{1}{545}$th of an inch in diameter: *a*, empty test covered with circular scales hexagonally arranged, also showing the broad side of the neck and open aperture; *b*, ditto, showing the narrow side (or lateral view) of the neck and closed aperture, also *c c*, supernumerary scales; *d*, test containing the animal, passive, with closed aperture; *e*, sarcode containing fragments of food; *f*, nucleus in posterior and granular portion of sarcode. England, fresh water.

XXXIII.—*Contribution towards the Knowledge of the* Rhynchoprion penetrans. By Hermann Karsten*.

[Plates VIII. & IX.]

[In this paper Professor Karsten remarks upon the imperfect knowledge which we still possess of this curious parasite—the Nigua, Chigoe, Jigger, or Sand-Flea of tropical America,—notwithstanding that the first European visitors to the New World

* Translated from a separate copy of the paper in the 'Bulletin' of the Society of Naturalists of Moscow, communicated by the author.

seem to have experienced its attacks. Its generic synonymy is given by Professor Karsten as follows:—

Pulex, Linn. 1767.
Rhynchoprion, Oken (not Hermann), 1815.
Sarcophaga, Guilding, MS., Westwood.
Dermatophilus, Guérin, 1836.
Sarcopsylla, Westwood, 1837.

Professor Karsten commences his memoir with a series of extracts from the various writers who have mentioned the Nigua, the references to which will be found in the accompanying list †. The results of his own investigations are then communicated in the following words.]

**Oviedo*, Cronica de las Indias, 1547, fol. xxi.
Hans Staden, Wahrhaftige History, &c., 1557, cap. 33.
Abbeville, quoted by *Sloane*, p. 256.
Jean de Lery, Voyage du Brésil, 1585, p. 168.
R. Hakluyt, The Principal Navigations, &c., London, 1598–1600, p. 449.
J. de Laet, Beschrywinghe van West Indien, 1630, p. 6.
Marcgrav Piso, Historia rerum naturalium Brasiliæ, 1648, p. 249.
R. Ligon, History of Barbadoes, 1657, p. 109.
Du Tertre, Histoire des Antilles, 1667, vol. ii. p. 353, § 12.
Rochefort, Histoire Naturelle des Antilles, 1668, cap. xxiv. art. vi. p. 272.
Hans Sloane, Voyage and Natural History of Jamaica, 1707–1725, i. p. cxxiv and ii. p. 191.
Frezier, Reise nach der Südsee, &c., 1718, p. 310.
Gumilla, Historia del Orenoko, 1745.
**Ulloa*, Relacion Historica del viaje a la America meridional, 1748, libro i. cap. viii. p. 88.
Catesby, Natural History of Carolina, &c., 1743, vol. ii. Appendix, p. 10. fig. 3.
Barrère, Nouvelle Relation de la France équinoxiale, 1743, p. 63.
Patrick Brown, Natural History of Jamaica, 1756, ii. p. 418.
Linné, Systema Naturæ, ed. 12, 1767, p. 1021.
Bancroft, Natural History of Guiana, 1769, p. 245.
Hartsinck, Guyana, 1770, i. p. 105.
Chappe d'Auteroche, Voyage en Californie, 1772, p. 20.
Molina, Saggio sulla storia naturale de Chili, 1782, p. 214.
**Dobrizhoffer*, Historia de Abiponibus, 1784.

The first educated naturalist who described the Nigua from personal examination was

**O. Swartz*, Kongl. Vetensk. Acad. Nya Handl., Stockholm, 1788, tom. ix. p. 46 (*Pulex penetrans*).
**Rodschied*, Medicinische und Chirurgische Bemerkungen über das Clima, &c., von Essequibo, 1796, p. 307.
Azara, Voyages dans l'Amérique méridionale, 1809.
Southey, History of Brazil, 1810, i. p. 326.
Von Sack, Reise nach Surinam, 1821, p. 239.
Oken, Naturgeschichte, 1815, Bd. iii. Th. i. p. 402 ("Rhynchoprion" referred to the Acari).

† The more important references are marked with an asterisk.

Humboldt, Voyage du Nouveau Continent, 1820–1822, tom. vii. cap. 19. p. 250, and cap. 20. p. 129.
Duméril, Considérations générales, 1823, pl. 54. figs. 4, 5.
Latreille, Règne Animal, 1829, iv. p. 351.
Kirby and Spence, Introduction, 1828, vol. i. p. 102.
**Pohl*, Reise in Brasilien, 1832, i. p. 106.
Aug. St.-Hilaire, Voyage dans Rio Janeiro, 1830, i. p. 35, and Voyage du Brésil, 1833, i. p. 228.
**Rengger*, Reise nach Paraguay, 1835, p. 274.
Waterton, Loudon's Magazine of Natural History, 1836.
**Dugès*, Annales des Sciences Naturelles, 2 sér. tome vi. 1836, p. 129.
**Guérin-Méneville*, Iconographie du Règne Animal, Insectes, p. 12 (*Dermatophilus*).
**W. Sells*, Transactions of the Entomological Society, vol. ii. p. 195.
**J. O. Westwood*, Ibid. p. 199 (*Sarcopsylla penetrans*).
**Tschudi*, Peru-Reiseskizzen, 1846, i. p. 310.
R. Schomburgk, History of Barbadoes, 1847, p. 652.
**Burmeister*, Reise nach Brasilien, 1853, p. 284.

All these descriptions originate in tropical and subtropical America, in the region which has always been regarded as the sole country of *Rhynchoprion penetrans*; the insect does not occur in other parts of the world.

Adanson, indeed, in his 'Voyage to the Senegal' (1757), mentions a kind of very small Flea, which resides in extraordinary quantities in the sand of the huts, for which reason it has received the name of the Sand-flea; but, from his further statements, it appears that he does not refer to the *Pulex penetrans*, Linn.; for he says, "Fortunately its puncture is not very painful, and it consequently produces so intolerable an itching only because it attacks the body in such great numbers. The most remarkable circumstance," adds Adanson, "is that the insect usually does not creep or leap to a greater height than three inches." The latter peculiarity, like the name, reminds us of *R. penetrans*; but, if it had been this species, Adanson would certainly have given us a fuller account of it.

The most southern habitat of *Rhynchoprion* is that given by Dobrizhoffer and Azara, namely, Paraguay, under the 29th degree of south latitude. According to Auteroche, it is very abundant in Vera Cruz, in 20° N. lat.; and from the same authority, as also from John Smith (cited by Sloane), the insect appears to occur up to the latitude of Virginia, about 30° N.

Everywhere the insect, which affects warm and dry places, is met with in the vicinity of human habitations, either occupied or deserted. All the accounts of the occurrence of this animal in fields, woods, and plantations are due to confusion with species of *Ixodes*, except when these statements refer to the leaf-huts made by field-labourers or travellers to give them shelter for a night or for a short time. Such huts or leafy roofs, when deserted by human inhabitants, usually become the dwelling-

place of rats, mice, and similar animals, which seek shelter there from the rains, so long as the roof offers it to them; and these animals then serve for the preservation and increase of any progeny of the Nigua that may have been left behind by the travellers; hence it is that such places often particularly abound in Niguas, which attack new-comers in great numbers, as I know from personal experience. The same thing occurs, as indeed Rengger relates, in the deserted houses of planters, in the rooms of which the Niguas developed from the eggs left behind at first collect in extraordinary numbers, but afterwards diminish again, and finally disappear entirely, no doubt because these places are not so convenient for the access and long residence even of the smaller mammalia, so that the Fleas cannot increase, and consequently at last die out.

Rengger's statement that animals living in a wild state are not attacked by the Nigua is consequently not correct, and has already been refuted by several travellers. In Schmarda's rich collection I found a Field-mouse from Cuença, the tail and foot of which harboured a great quantity of Niguas* (Pl. VIII. fig. 1).

Swartz, Rengger, Humboldt, and other travellers report that strangers are particularly attacked by the Sand-flea on their arrival in America. It is true that new comers, to whom the inconspicuous insect is unknown, have usually to suffer more from it than others. During my residence in Venezuela I was myself much plagued by it at first, whilst in the latter years of my tropical travels in New Granada I was scarcely ever attacked by a Nigua, although the Creoles at the same places complained much of them. This, however, is favourable neither to Humboldt's hypothesis of the delicate discrimination of the Nigua between European and Creole blood, nor to Rengger's notion that the human body loses some property which attracts the Nigua.

The fact that in newly arrived foreigners the Niguas collect in greater numbers, acquire a larger growth within the skin, and consequently cause more violent symptoms, admits of this simple explanation:—The strangers do not notice the slight tickling produced by the penetration of the animal into the skin, as they do not understand the meaning of this slight pain; and the animal, after it has taken its place, causes no further inconvenience, if the slightly inflamed spot of skin which it inhabits

* Of these Niguas I removed two from the skin, in order to examine their specific characters. I could find no perceptible difference from the other individuals examined; but I noticed the very remarkable fact, inexplicable by me, that in both of them all the legs were wanting up to the trochanters.

is not pressed or scratched. The particular state of the skin as regards irritability will also have its influence, as also the greater or less activity of the skin. It is true that the inhabitants of Caracas have also remarked that, of newly arrived colonists, the French, like the negroes, suffer particularly from the parasitic flea.

The Nigua is a parasite only during one period of its life; for the impregnated female alone bores into the skin of warm-blooded animals: the unfecundated females and the males do not live parasitically. The dark brown colour of the contents of the stomach in the animals which are found running about indicates that, like the allied Fleas, they live on blood.

The true colour of the body of the free-living Niguas (leaving out of consideration the dark colour of the contents of the stomach) is yellowish; I have never seen a brown or black *R. penetrans*, such as are mentioned by Ulloa, Auteroche, and many others. The dilated bodies of the Niguas which had established themselves under my own toe-nails, and more rarely on other parts of the skin, as also of those which I observed on other people and on animals, were of a more or less pure white colour; those derived from the skins of negroes appeared grey—probably only influenced by the pigment existing there. No differences of form could be detected.

From its light colour, the size of the Nigua has been greatly underrated by most describers; for it measures, on the average, 1 millim. (half, or more than half, the size of the common Flea). The males and females are at first of the same size, and it is only during the endoparasitic life of the fecundated female that its body enlarges to the extraordinary diameter of 5 millim.

As long as the pregnant female remains in the skin undisturbed by pressure or rubbing, it produces, as far as my experience goes, no further perceptible inconvenience; it grows to the size above mentioned, and in this condition remains long without alteration. The inconsiderable inflammation, exciting a slight tickling sensation, which is produced in the skin by the assimilating animal, is greatly increased by any irritation of the part affected, and might probably, in bad constitutions, give rise to those destructive effects which have been cited by various writers, and which I have also heard spoken of. I have frequently seen young negroes with purulent feet destitute of toes, limping about upon their heels, who indicated the Niguas as the cause of their sufferings. Consequently it is possible that there may be some truth in the narrative of Walton, cited by Kirby and Spence, of the capuchin who had to pay with his foot for his desire to make this animal known in Europe.

There is no doubt that negroes are often attacked by tetanus

when they wet their feet with water after the extraction of a Nigua; but this is no peculiar effect of the Nigua.

The swelling of the inguinal glands, observed by Ulloa and Jussieu, which led them to conclude that a second species existed, occurred once in my own person in La Guayra. Whether this phenomenon is the specific effect of a peculiar species of animal, or to be referred to the same category with the similar consequences of other slight injuries to the lymphatics of the foot, which is my own opinion, must be left to the future to decide. Spix and Martius also mention swellings of the inguinal glands in consequence of the penetration of Niguas.

I cannot from my own observations confirm the opinion that there are two different species of Niguas, a malignant and an innocuous kind, of which the latter, according to Ulloa, is of a dark colour.

The inflation of the abdomen in the Flea, when imbedded in the skin, takes place very rapidly, as has been remarked by all observers. Ulloa's statement that the animal enlarges to a diameter of two lines in four or five days, according to the individual nature of the insect and of the subject attacked by it, may be regarded as nearly correct.

The animal imbedded in the skin, usually under the toe-nails, when it has become quiescent in its new dwelling-place (that is to say, when it has got so far under the epidermis that its anus, lying at the same level, closes the orifice formed in the epidermis) produces scarcely any inflammation or sensation of pain, unless, as already stated, the affected spot is injured or irritated by pressure or friction, in which case both these symptoms make their appearance, just as in a frozen limb. The increased heat and softness of the skin, in consequence of the inflammation, attract other Niguas, and facilitate their penetration in the vicinity of the first one. This is the cause of the juxtaposition of several Niguas, described by various authors, and which, indeed, is not unusual—and not, as stated by all writers since the time of Oviedo, the exclusion of the larvæ from the eggs in the wound or in the uninjured body of the mother. Even Pohl and Kollar, probably misled and rendered doubtful of the correctness of their own observations by the statements of their predecessors, adopt this notion of Oviedo's, although they rightly understood the conditions of development and the deposition of the eggs.

As is so frequently the case, the simplest and most natural state of things is the last to be recognized as the true one, after all sorts of by-paths have been tried (I need only refer to the theories of the origin and metamorphosis of the organic cell); and the same thing has occurred here.

For we may easily be convinced that eggs alone, and never larvæ, are contained in the female flea, and that the most perfect of these lie nearest to the cloaca; and any one who has frequently had to remove the dilated female from the skin will have remarked the projection of a perfectly mature egg from the body of the mother on the slightest pressure being applied to the latter with the needle, &c. The very numerous ovicells which occur in the cylindrical tubes of the simply furcate ovary are gradually developed in such a manner that the most mature egg is always situated next to the issue, and is driven forth by the pressure of the other growing ova before the process of segmentation or any other commencement of embryonal development has taken place. In this way the parent animal remains within the skin without any further enlargement until all the eggs are developed and deposited, after which, no doubt, the evacuated and shrivelled body is finally thrown off with the epidermis during the advancing development of the skin—an opinion which might perhaps be fortified by the statements of Rengger (p. 110) and Burmeister (p. 126).

Rengger's statement that the mature egg-sac separates from the organism which has furnished it with nutriment, and that then, in a few days, a number of larvæ creep out of it, is refuted at once by the mode of lodgment and the constant enclosure of the body of the Flea in the skin.

The extraction of the parasite from the skin is, as stated by Gumilla, far more easily effected at a later period than in the first hours and during the penetration, because then the animal, which is working briskly, only increases its efforts by the aid of its mandibles, which are peculiarly adapted for the purpose, and, indeed, fastens these so firmly in the skin that they are not unfrequently torn away from the body of the Flea, and remain sticking in the skin, when the animal is removed with violence. As early as the next day the voluntary activity of the animal is much diminished, and then, but with still more certainty after the lapse of a few days, with a little care the epidermis may readily be pushed aside with a blunt knife or a needle, all round the Flea without injuring the latter, and thus the globular animal may be so far exposed that these instruments or a fine pair of forceps may be got under its body, and it may then be removed without much resistance and by slight pressure, with all the buccal organs, which project far into the true skin (the rootlets or filaments of Sloane, Ulloa, and Schwartz). But if, in removing the dilated and delicate body which adheres more or less closely to the surrounding cellular tissue of the skin, we proceed so clumsily as to tear it, so that a portion of it, with the piercing-apparatus imbedded in the corium, is left behind in the

skin, lymph flows continually from the wound, and a purulent condition soon setting in converts the originally small wound into a more or less extensive sore.

The opinion expressed even by the first writers on this parasitic animal, and repeated by various later authors, that there are two species of its genus, is founded by them partly on the difference of coloration already referred to, and partly on the length of the buccal organs. In all the animals examined by me, however, the latter were at the utmost about one sixth longer than in the common Flea, attaining scarcely half the length of the body of the free animal; whilst Linnæus and his successors characterize this species by the piercing-apparatus being equal in length to the whole body. From my own observations, I should have been the more inclined to regard this statement as erroneous, because I do not find it noticed by any of the predecessors of Linnæus with whose works I am acquainted (I have been unable to find Rolander's statement with regard to this insect, cited by Linnæus), if Westwood did not expressly confirm the Linnæan diagnosis. Westwood examined the specimens brought by Sells from Jamaica. Swartz also observed the animal in that island, but he figures the mandibles as only of the length observed by me. Is it possible that the limits of distribution of two species of this genus of Fleas may coincide in the Antilles,—namely, a long-beaked North American species and a South American one with shorter buccal organs*? Westwood's figures of this animal, imperfect as they are, are favourable neither to this hypothesis nor to the accuracy of his investigations, as they also represent the mandibles of the usual length.

We are therefore at present with certainty acquainted only with one species of Nigua; the existence of a second species has still to be demonstrated, although Westwood has already given it a name by anticipation, calling it *Sarcopsylla Canis* from the supposition that it especially inhabits dogs, notwithstanding that the Nigua taken from a dog, and fully described by Pohl and Kollar, is regarded as belonging to the Linnæan species.

For the earliest account of the different organs of which the piercing-apparatus of *R. penetrans* is composed, as also of their form, we are indebted to Dugès, who detected the maxillæ with their palpi, the median piercing-organ, the structure of the mandibles, and the presence of the labium. More recent observers have not completed these statements; on the contrary, the

* Besides the above-mentioned specimens of *Rhynchoprion*, brought by Schmarda from Cuença, and those which I observed in Venezuela and New Granada, I have examined others brought by Dr. Carl Martin from San Paulo, in Brazil, and entrusted to me for this purpose.

maxillæ have not again been detected, although they are present, and nearly of the form figured by Dugès. These maxillæ (Pl. IX. figs. 3, 4, & 13) are so broad that they cover the base of the mandibles with their anterior margins, which do not project beyond the cheeks, but are fringed with several rows of fine setæ directed downwards. They are flat, almost triangular, lie close together, and bear on their outer surface, near the upper margin, the four-jointed palpi (Pl. VIII. figs. 3 & 8, and Pl. IX. figs. 1 & 13), which are roughly setose above, and of which the lowest, longest joint is bent inwards at its base, and furnished on the outer surface of the curvature with a circular orifice, or, rather, membranaceous spot.

The length of the first three joints of these palpi varies remarkably in different individuals: sometimes these are all of equal length; sometimes the third is the largest; sometimes the second exceeds the other two. The comparative length of these joints furnishes no certain and constant character.

The mandibles (Pl. IX. figs. 12 & 13) are about one-fourth longer than these maxillary palpi, and remarkably similar both in form and size to those of *Pulex irritans*, Linn.: their form is that of linear, shallow channels; on the margin and external surfaces along the margin they are nodosely notched and striated; in the median line of the organ these striæ are separated from each other by a smooth surface. At the base, which is covered by the maxillæ, the striation is lost at the upper margin, and is only indicated by some acute denticles standing singly on the margin. At the apex itself (Pl. IX. fig. 12), where the nodose striæ of the lateral surfaces are much diminished, and only indicated by a few knots, there is, in each mandible, at the extremity of the smooth median surface, a small hook, curved outwards and attached by an enlarged base, which is no doubt partly the cause of the difficulty of extracting the animal when still capable of quick motion and engaged in boring into the skin.

In the cavity of parabolic section which these two channeled bodies enclose between them is situated the median piercing-organ (Pl. IX. figs. 13 & 14), the analogue of the epipharynx of the Diptera, the much-dilated base of which lies under the vertex, above the eyes, and forms the commencement of the œsophagus. This organ also is a channeled body, the hollow side of which is turned downwards (figs. 10 & 11). Although at the first glance this organ resembles a two-edged linear lamina, it is nevertheless prismatic in form, as its lateral walls diverge more or less rectangularly. The dorsal surface forms a sharply projecting cutting-edge, furnished at the anterior extremity with three distant teeth, of which the last one, nearest the

apex, is directed backwards, and the two others forwards. (These teeth occur in *Pulex irritans* in greater number, and along the whole length of the organ.) Internally each of the two delicate lateral walls of the channel is furnished with a thickened ridge, very finely transversely striated; by these ridges a nearly closed tube is formed at the base of the channel. At the anterior, open end of this tube, which is open longitudinally above, a strong spine is attached on each side, the apex of which projects a little beyond the body of the channel. Near these two larger spines there are also on each side four (in *P. irritans* three) somewhat weaker acicular points, which appear to be the extremities of very delicate lamellæ attached in a longitudinal position to the base of the channel. Of these, one is even a little broader than the lateral walls of the channel, so that it is seen projecting beyond these when the organ is lying on its side; this lamella (which is probably double) is somewhat chitinized, or at least of a yellowish colour, at its anterior extremity, which forms a strongly projecting tooth, whilst the others are so delicate and transparent that they are visible only with very favourable illumination, and nothing can be ascertained with certainty as to their form and mode of attachment.

In *Pulex irritans*, Linn., the organ, which is very little smaller, has nearly the same structure; but this is recognizable with difficulty in both species on account of the great delicacy and transparency of the individual parts. This piercing- and sucking-organ is not covered by an upper lip, as in the Diptera; in this, as in the allied *Pulices*, the labrum is wanting.

The labium, on the contrary (Pl. IX. figs. 3, 4, 7, 8, & 13), is just as completely developed as in the latter; it is as long as the mandibles, which it embraces from beneath, and more or less completely surrounds. The labium is divided, as in *P. irritans*, into three regions: the lowest part, which is gibbous beneath, is inserted upon the mentum (*k*, figs. 3 & 4), and is prolonged into an unjointed channel of nearly the same length, open above and anteriorly somewhat cleft. On each of the two short terminal pieces, which are truncated and greatly emarginate anteriorly, there is seated, as the third part of the labium, a linear-lanceolate, somewhat concave lamella, of the length of the two preceding regions taken together, or even somewhat longer; but this is neither jointed nor beset with bristles as in *P. irritans*. As these two palpiform appendages are attached by a narrow base to the truncated extremities of the body of the labium, they are readily broken off (Pl. IX. fig. 4 *l*), for which reason they were not observed by Dugès and Guérin.

This organ is of the same form and size both in males and females; nor does the external form of the rest of the body pre-

sent any sexual variations, with the exception of differences in the form of the external generative organs. The feet (which were correctly described by Dugès) and the head and thorax are very similar in form in the two sexes.

The head is somewhat flattened on the vertex, which borders the perpendicular, almost triangular forehead, and is separated from the forehead and cheeks by a somewhat prominent ridge, having a row of small, straight, strong bristles. The occiput, which is arched and covered with very delicate hairs, comes down upon the flat, nearly concave, and likewise finely haired vertex in the form of a median ridge, which is completely obliterated at the frontal margin.

The large oval eyes are simple in both sexes, the cornea covering them exhibiting no facets. The very large optic nerves, which, like cerebral hemispheres, occupy a great part of the head, nevertheless show very distinctly on their surface the ends of the numerous nervous filaments of which they are composed.

Behind the eyes, sunk in a pit of the cheeks, are the large three-jointed antennæ, the oval terminal joint of which is covered with fine setæ, and appears to be pierced on the upper and posterior side by a row of six oval attenuated spots, each of which is circumscribed by a thick ring. At its obtuse end this oval organ is attached by means of a long cylindrical stalk to the middle joint, which is of nearly the same size and of a clubbed hammer-shape; and this stalk is inserted in a circular orifice in the latter, within which it can be retracted. The delicate membranes above mentioned as closing the apparent orifices in the free oval terminal joint are protected from contact from without by means of long setæ curving over them, which spring from the hammer-like projection of the middle joint near the orifice already described. The very small ellipsoidal basal joint is inserted at one end into the upper posterior angle of the antennary pit, and at the other simply articulated to the second joint (Pl. VIII. fig. 2).

The three narrow but free thoracic segments, of which the posterior is partially concealed by the hinder margin of the preceding one, are somewhat dilated below, where they are pierced by a stigma which leads into a narrow trachea; with their lowest extremities they border the three immoveable epimera into which the coxæ are articulated.

The third or hindmost of these coxæ terminates below and anteriorly in the large and striking spinous process, to the discovery of which Guérin attributed great importance. The very powerful femur, which is united to this large posterior coxa by means of the trochanter, bears a series of strong bristles along the middle line of its outer surface. The first tarsal joint

of the posterior feet is fringed or pectinated at its lower edge with strong setæ; the broad coxæ and femora, which are sharp above and in front, are furnished with an emargination at the extremities of the side of flexion; from this the elastic tissue by means of which the projection of the animal is effected, projects in the form of a pad or cushion. (The form and garniture of the legs are shown in the figures of the animal in Plates VIII. and IX.).

In running, the two hind legs, which are then perfectly inactive, are drawn along; and only the four anterior feet move, in alternate pairs. In leaping, the animals only rise a few inches.

To the third or hindmost thoracic segment a pair of large, nearly triangular, wing-like plates, lying close to the body, are immoveably attached; in their broadest part, which occurs in the median line of the body, they attains nearly half the length of the abdomen. Like the segments of the body, they are uniformly chitinous. Between these two wing-like plates the middle of the first long but narrow dorsal half-segment is left uncovered.

No so-called second pair of wings is present, although there is a narrow lateral plate, which, like the wing, by which it is completely concealed, is attached to the posterior thoracic segment, and applies its upper and lower extremities to the margins of the narrow first dorsal and ventral half-segments. (This organ, with its stigma, is shown shining through the wing-lamina in Pl. VIII. fig. 3, and Pl. IX. fig. 1.) I cannot regard these organs as a second pair of wings, both on account of their immoveable attachment, with the first pair, to the third thoracic segment, and also on account of the occurrence of a stigma in their upper extremities, by which they show themselves to belong directly to the integument of the body.

Each of the two wing-like appendages of the third thoracic segment bears on its upper portion two rather distant, strong bristles, which are bent backwards. On some individuals I found exceptionally only one of these bristles.

A similar bristle springs on each side from each of the eight dorsal half-segments of the abdomen, of which the first, which is narrow, is not a complete half-segment; but the others, with the corresponding overlapping ventral half-segments, completely surround the abdomen.

Besides these complete chitinous half-segments, which are united by a delicate folded membrane, and overlap each other at the margins like the thoracic segments, there is, at the posterior extremity of the body, a number of plates more or less cleft and converted into variously formed appendages of the generative organs, according to the sex of the individual.

In the males the stigmata occur in the vicinity of the bristles,

a little before and underneath the latter. On the first seven abdominal segments these stigmata are narrow circular orifices, like those of *Pulex irritans*, which lead into equally narrow tracheæ, and are surrounded by a narrow six-celled margin (Pl. VIII. fig. 7). On the eighth or last complete half-segment there is a stigma, of six times the width of the others, opening into the cloaca, and surrounded by a circle of bristles, which converge over it and close the orifice (Pl. IX. figs. 1 & 2). The trachea of this stigma is about twice the diameter of the others, with which it unites on each side of the body to form a common longitudinal stem, from which branches are given off to the organs.

The tracheæ of the female are essentially different, both in number and arrangement, from those of the male; for in them, besides the great cloacal stigma with its very wide trachea (almost three times as large as the corresponding organ in the male), there are only three very wide tracheæ in the seventh, sixth, and fifth dorsal half-segments, with proportionately wide stigmata, which are very similar to the great cloacal stigma.

The large spines which converge over these wide stigmata of the female, as also over the cloacal stigma of the male, and protect the tracheæ from the intrusion of solid bodies, spring from the last tracheal annulus, the *peritrema* (Pl. VIII. figs. 3 & 6); whilst from the annuli of the lung-sac or dilatation of the neighbouring ends of tracheæ, similar spines, standing obliquely erect and reaching as far as the median line (such as are known to occur in *Lampyris*), appear to assist in the attainment of this object.

The three next abdominal segments forwards have no stigmata in the females; but the short first dorsal half-segment attached to the third thoracic segment is furnished on each side with a small stigma analogous to those of the male, and the lateral plates described as lying under the wings are also, as already mentioned, provided with a similar stigma at the superior extremity.

In the female the three large lateral stigmata, like the seven narrow ones of the male, are situated so near the basal margins of the dorsal plates that they are covered by the posterior margins of the next plates, and are only recognizable by transmitted light, when they shimmer through the plate lying over them.

The four very wide cylindrical main tracheal stems on each side of the abdomen in the female divide each into two branches, one of which unites with the rest to form a stem running along the side of the abdomen, from which smaller branches are given off to the internal organs, which also receive ramifications of the second branch of the main stems.

It is remarkable that, during the parasitic existence of the female, its tracheæ entirely lose their peculiar spiral structure, and acquire considerably thickened walls; these changes take place first in the finer ramifications, and subsequently in the branches and stems, which, before the thickening becomes perfectly uniform, sometimes acquire a porous aspect. The cause of this extraordinary phenomenon, connected as it is with parasitic existence, is probably to be sought partly in the altered mode of nourishment and partly in the residence of the animal within the tissue, more or less permeated by fluids, of the living organism which furnishes the nutriment. On the one hand, by continual sucking, an extraordinary amount of fluid is taken up (if we may judge from the constant issue of lymph after unsuccessful operations, as already mentioned); and on the other hand, the evaporating surface of the animal is reduced to a minimum. The greater part of the integument of the parasite is entirely prevented from taking part in transpiration; those segments which contain the last stigmata transpire more or less incompletely, as even these segments have only a very small part directly exposed to the atmosphere. Perhaps this may be the cause of the considerable thickening both of the true air-passages themselves and also of these last abdominal segments; whilst the anterior and larger segments of the abdomen lose their chitinous plates by stretching them into very delicate membranes.

As I found no air in these altered and thickened tracheæ, it would almost appear as if these air-canals had suspended their normal functions during the parasitism of the insect—as if the tissue forming them vegetated on in an altered form independently of the developmental laws otherwise governing them, whilst the ovicells assimilated the unaltered lymph of the nutritive organism, which is continually brought to them by means of the sucking-apparatus acting by capillarity and adhesion. For the entire tractus intestinalis appears, as in chrysalides, to be subjected to a retrogressive metamorphosis; and the life of the animal during its parasitism, like that of many other endoparasites, seems to become purely vegetative.

Do the aëriferous tracheæ change their function in such a manner, during the residence of the animal in the tissues of the skin, that they are filled with lymph, instead of air, through the stigmata, and in consequence become thickened? This hypothesis, improbable enough in itself, is contradicted by the circumstances, that the last stigma of each side, which opens into the cloaca, is always freely exposed to the air, and that the stigmata concealed by the dermal tissues are not in the corium, but applied to the dry, horny epidermis (at least, the three pairs of

wide stigmata), and so closely that apparently neither air nor fluid can find its way into them; and, further, that in animals which had lived for some time in the skin I could find no fine tracheal ramifications of the ordinary spiral structure, whilst these must at least have remained in connexion with the cloacal stigma in case the want of access of air or the penetration of fluid had induced the alteration of structure in the anterior tracheæ.

In the animal in a free state, the alimentary canal shows the same complicated structure as in the *Pulices*. Whilst particular sections of it exhibit a greater delicacy, a greater development of the glandular appendages occurs; so that it would appear that the chylification of the food is rather effected chemically, whilst in *Pulex* mechanical arrangements assist in the operation. The latter applies especially to the nearly globular proventriculus, which, in *Pulex irritans*, is horny, folded, and internally almost spinose, whilst in *Rhynchoprion* it is simply membranous, and internally papillarly glandular. Similar papillar glands occur in the large membranous true stomach of both species, especially in the vicinity of the anterior orifice. Before the crop, there is in *Rhynchoprion* a long muscular œsophagus, which appears to assist the passage of the inhausted nourishment into the stomach by powerful peristaltic movements; for it is always found constricted into a number of globular sections. At the commencement of the œsophagus there are two tufts of cylindrical salivary glands, each inserted by a common efferent duct; and instead of the small pedunculate pyriform glands, which in *Pulex* open into the intestine, as Malpighian vessels, in the vicinity of the pylorus, there are, in *Rhynchoprion*, two very long glandular tubes, which pour their contents by a common efferent duct into a region of the intestine which I cannot exactly particularize, as I never succeeded in observing these organs in connexion.

Of all these organs forming the tractus intestinalis, I could not with certainty detect anything in the dilated parasitic female—or, at least, I could recognize nothing with certainty—as any parts of the stomach and intestine that might have been present were so much softened as to lose all connexion during preparation.

That the ova, which now alone fill the much-dilated abdomen, and which have grown to an extraordinary size, are not, as stated by all previous observers, hatched in the body of the parent, is shown not only by the fact that fecundated ova are never found in the parasite, but also by the period of fecundation necessitated by the anatomical conditions.

The large ova, which grow to about half the length of the

unimpregnated animal (Pl. VIII. fig. 5), and in the outer pergamentaceous capsule of which there is at each end a group of small pores (the so-called micropyles), lie in the part of the ovary nearest to the vagina (Pl. VIII. fig. 12 *v*), and close to its efferent duct (fig. 12 *u*), without exhibiting the least sign of fecundation.

This efferent duct, which is common to the two ovarian tubes, opens into the fecundation-sac (fig. 12 *b*), formed of a delicate elastic membrane, into which the long afferent canal from the large seminal receptacle opens; the latter is filled with long filiform spermatozoids, which are not free in this receptacle, but each of them is rolled up singly in a spiral, and cemented into a small ellipsoidal corpuscle by a substance which is soluble in water. The pyriform seminal receptacle is composed of an elastic tissue, and is coated externally with striated muscular fibres and cellular tissue. If the seminal receptacle, taken from a recently killed animal, be torn under water, the small ellipsoidal spermatophores (fig. 10) with which it is filled break up, and from each of them is evolved a long seminal filament (fig. 11), which moves for some time in water.

It was found impossible to observe a mature ovum in the fecundation-sac; for, as soon as the operation of extracting a pregnant female from the skin is commenced, a large egg is usually projected from the cloaca, no doubt in consequence of the pressure exerted upon the insect. The fecundation-sac is therefore always found empty and collapsed (as here figured).

The natural process, in my opinion, is as follows:—The ripest ovum, impelled into the fecundation-sac by the pressure of the increasing ova behind it, meets there with some spermatozoids, which have previously been set free and migrated from the seminal receptacle; these fecundate it, excite in it the process of cell-formation, and induce the development of the embryo. In consequence of these processes, the egg begins to enlarge and to expand the elastic fecundation-sac, and it is finally expelled through the vagina in consequence of the pressure applied to it by the sac.

If the development of the larva in the one fecundated egg took place in the fecundation-sac or the oviduct, there would always, as in the *Pupipara*, be only one larva in the parasite; but the penetration of this larva into the nutritive body, associated as it would be with perforation of the walls of the mother, would prevent the natural development of all the other ova. For the position of the cloaca in the orifice of the epidermis produced by the penetration of the parasite, and immediately at the surface, would render it necessary, in order that the excluded larva might reach the mucous membrane, that it should

penetrate through the epidermis, upon which it must first of all get (which can hardly be regarded as probable); or else we must assume (as indeed is done by the majority of writers on this subject) that several larvæ are developed simultaneously in the ovary, and that these then break through the integuments of the mother and thus reach the inner parts of the skin. The anatomical characters above described do not accord with this assumption of viviparity.

The external sexual organs of the female consist of the cleft terminal abdominal segment, forming apparently two pairs, which preserve their form unchanged during the parasitic life of the animal, and surround the cloaca, which lies parallel to the surface of the skin, standing perpendicularly upwards.

In the male also (Pl. IX. figs. 1, 2, & 9) the last segments of the body are cleft, and of very peculiar form. Even in the still undivided seventh half-segment, the ventral lamina, which in general is somewhat less than the dorsal, is considerably smaller and almost canaliform (figs. 1, 2, & 6). Then follow two pairs of valvular or scale-like organs (fig. 6 *a*, *b*), each of which should probably be regarded as a cleft and metamorphosed dorsal or ventral plate. These laminæ serve as the coverings of the external organs of the generative apparatus (fig. 6; fig. 5, seen from above). Beneath the upper external valve (*a*) on each side a long-stalked forceps-like organ (*k*) is concealed, which evidently serves the male as an organ of support and adhesion during copulation. The branches of the forceps are shovel-shaped; the lower one moves upon the upper one by a broad two-armed hinge, and both are fringed round the anterior margin with long stiff bristles. The inferior pair of valves (*b*), which are longer than the upper, and clothed with short bristly hairs, cover the base of two long tubuliform channeled organs (*x*), open above throughout nearly their whole length. These have their inner margin recurved inwardly and notched, and by means of this are connected with another, central channeled organ (*z*) open beneath,—the lateral walls of this organ, which are likewise recurved inwardly at the middle part, being interlocked with them, whilst posteriorly they are rolled inwards and form two tubes for the reception of the two seminal canals (*v*). Two long narrow laminæ (*y*), with the upper margin undivided and the lower one emarginate in the middle, conceal this organ from above. During copulation, these laminæ bend downwards almost at a right angle from their narrow middle part (*e*), and thus no doubt serve to attach the two individuals to each other. The central channel (*z*), which is open below, has, on the lower surface of its decurved apex, a fine orifice, which evidently serves for the passage of the extremity of the long, round, filiform, but

tubular penis (*p*), which has its apex bent downwards. I found this organ once protruded from the rest of the generative apparatus in the manner shown in fig. 6, in a male engaged in the act of copulation; in another individual, in which it was likewise protruded, I found the apex broken off. This central channeled organ (fig. 6 *z*), which immediately encloses the penis, is engaged at its base in another channel open beneath, enclosed in the abdominal cavity of the animal, and the lateral walls of which are dilated anteriorly into broad, nearly rhombic laminæ (*p*), which can be drawn towards the anterior walls of the abdominal cavity by means of broad muscles (*m*).

In the bottom of this channel, turned towards the back of the animal, and between these two plates, is attached the long, slender, linear stem of a stirrup-shaped or two-armed and almost sledge-shaped body (*s*), directed towards the lower and anterior region of the body, upon which a muscle, attached to the posterior extremity of the abdominal cavity, is inserted. By means of these two muscles the entire sexual apparatus can be protruded and retracted.

The margins of the slender stem-like part (fig. 6 *c*) of this channeled chitinous organ are bent upwards, and thus again form on the inferiorly open channel a narrower channel open above on each side, in which the two multifariously twisted seminal cords (figs. 5 & 6 *v*) probably lie; these convey the long filiform spermatozoids produced in the testis (*g*) into the central channeled organ (*z*) in which the penis is concealed.

When the sexual apparatus is retracted, the canal of the seminal cords (*c*) forms with the sheath of the penis (*z*) an angle of 45°, turned upwards; the laminar extremity is situated in that region of the abdomen which is covered by the wing-plates. (It is shown through the integument in Pl. IX. fig. 1.) In fig. 6, to save room, it is shown in an oblique position, although truly, in the protruded condition of the external generative organs here delineated, the organs *c* and *x* form a still more obtuse angle.

From the form of the male sexual apparatus it follows that in copulation the female is not borne by the male, as in *Pulex irritans*, but that the female carries the male.

Besides this peculiarity, the different formation of the respiratory organs consequent on the parasitic mode of life, the different form of the maxillæ, and also the form of the palpiform appendages of the cleft labium are the chief characters which warrant the separation of this insect from the genus *Pulex*, as the type of a peculiar generic group. The labium of *Pulex* is indeed equally deeply cleft; but its sections are not jointed as in our animal, but only pseudo-articulated by the chitinization of

different parts, whilst the long moveable terminal joint of each half of the labium in *Rhynchoprion* is not chitinous, and exhibits no division into joints.

EXPLANATION OF THE PLATES.

(The magnifying power is indicated near the number of each figure.)

Plate VIII.

Fig. 1. A posterior leg and a portion of the tail of a Field-mouse, with several imbedded individuals of *Rhynchoprion*, brought by Schmarda from Peru.
Fig. 2. An antenna.
Fig. 3. A female animal before its parasitism: at *u* the entrance into the fecundation-sac is shown, and under the large wing-like organ the smaller lateral plate pierced by a stigma.
Fig. 4. A female after it has been imbedded in the skin for some days.
Fig. 5. A mature egg from the ovary, under the same power as the female in fig. 3: *m*, the micropyle.
Fig. 6. One of the large stigmata of the posterior dorsal half-segments of the female, with the neighbouring tracheal terminations.
Fig. 7. A stigma of the male, with a short trachea; magnifying power the same as for fig. 6.
Fig. 8. Head of the female (fig. 4), seen in front.
Fig. 9. A female that has attained its full development in the skin, seen in front.
Fig. 10. Spermatophora.
Fig. 11. The spermatozoids evolved therefrom, both taken out of
Fig. 12. The seminal receptacle, the efferent duct of which opens into the fecundation-sac (*b*), which is prolonged, on the one hand, into the efferent canal (*a*) of the ovary, and on the other into the vagina (*v*), with its mouth (*u*).
Fig. 13. A portion of a greatly thickened trachea of the parasitic female.
Fig. 14. Another greatly thickened tracheal branch, of which the inner originally spiral portion, which is now uniformly thickened, lies in the tenacious internal enveloping membrane.

Plate IX.

Fig. 1. A male *Rhynchoprion*; the internal chitinous parts of the sexual apparatus indicated as shining through.
Fig. 2. The abdomen of an individual in which the sexual organs were protruded.
Fig. 3. A maxilla (*mx*), with the maxillary palpi (*t*), the mandible (*md*), the labium (*l*), and the mentum (*k*), drawn from the inside.
Fig. 4. The same, from the outside.
Fig. 5. The external parts of the sexual apparatus, seen from beneath, after the individual parts had been somewhat separated by a gentle pressure.
Fig. 6. The same parts, with the organs situated within the abdominal cavity, seen from the side (see p. 309).
Fig. 7. The labium, seen from beneath.
Fig. 8. Its lower part, seen from above.
Fig. 9. A male animal, seen from above.

Fig. 10. The anterior extremity of the median piercing-organ, seen from below.
Fig. 11. The same, seen from the side.
Fig. 12. The apex of a mandible, seen from the outside.
Fig. 13. The organs of the mouth separated by pressure, in connexion with the œsophagus (*o*) and one of the salivary glands opening into it (*g*), the proventriculus (*p*), the stomach (*s*), and the intestine (*d*).
Fig. 14. The median piercing-organ, seen from the side.

XXXIV.—*Notices of British Fungi.* By the Rev. M. J. Berkeley, M.A., F.L.S., and C. E. Broome, Esq.

[Plates XIII.–XVII.]

[Continued from vol. vii. p. 458.]

It will appear from the present notices that the Fungi of the British Isles are by no means exhausted, even as regards the more noble species. The Rev. G. H. Sawyer has opened out quite a new field in the neighbourhood of Ascot, where he has detected two important genera, *Sparassis* and *Rhizina*, together with several species not hitherto detected in Great Britain, besides rediscovering the long-lost *Helvella pannosa* of Sowerby. Mr. F. Currey has moreover detected a true *Nidularia*. Scotland, Wales, the West of England, and Warwickshire have also afforded such a good harvest as greatly to encourage further research, especially in those districts which have not hitherto been explored. Meanwhile the importance of this tribe of plants in an economical and nosological point of view is daily more generally recognized; so that we may consider the study rather in the ascendant, and may hope for new labourers in the field, in which we are glad to hail Mr. M. C. Cooke as a recent and valuable colleague.

986. *Agaricus* (Amanita) *spissus*, Fr. Ep. p. 9; Currey, in Linn. Tr. vol. xxiv. p. 151.

Combe Place, Lewes, F. Currey.

**A.* (Lepiota) *meleagris*, Sow. t. 171. This species came up abundantly in a hothouse at Coed Coch, Denbighshire, amongst spent tan, both in 1861 and during August of the present year, and is certainly a Lepiota closely allied to *A. clypeolarius*. Two forms occur which run into each other, the less typical of which has a campanulate obtuse pileus, and is of a darker tint when dry.

Pileus at first ovate or hemispherical, very obtuse, fawn-coloured, minutely tomentose and warty, then expanded, subcampanulate, about 2 inches across, dotted with minute brown scales; stem at first fusiform, then nearly equal, of the same

Karsten, Hermann. 1865. "XXXIII.—Contribution towards the knowledge of the Rhynchoprion penetrans." *The Annals and magazine of natural history; zoology, botany, and geology* 15, 293–312.

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