BIHANG TILL K. SVENSKA VET.-AKAD. HANDLINGAR. Band 7. N:o 5.

ON

ANNELID REMAINS

FROM

THE SILURIAN STRATA

OF

THE ISLE OF GOTLAND

BY

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WITH THREE PLATES.

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Such an intimate connection exists in the invertebrate fauna of the Silurian Strata of North America, England and Scandinavia, that from the occurrence of any particular group of invertebrate organisms in the rocks of this period in any one of these countries, we may confidently expect that similar or very closely allied forms will also be met with in the same strata in the other two areas. This belief induced me, two years since, to pay a visit to the Isle of Gotland, with the view of ascertaining if there existed in the undisturbed Silurian strata of that island, so renowned for the exceeding richness and perfect preservation of its fossil Corals, Crustacea and Brachiopoda, any of those minute remains of Annelids, which I had discovered in the Silurian rocks of Canada and England. My hopes of finding similar fossils in Gotland were confirmed by the fact, which I have mentioned in my paper on the Annelid Jaws of Canada [Quart. Jour. Geol. Soc. Vol. 35 p. 370] that an undoubted example of these minute bodies had been figured by PANDER from the Silurian rocks of the Island of Oesel [Monogr. d. foss. Fische des Sil. Systems des Russ.-Balt. Gouvernements p. 72 Pl. 4, f. 16 a, b, c, d.] and they were realized, when on visiting Prof. G. LINDSTRÖM at Stockholm, I was shown some shale from Wisby in which fragments of Annelid Jaws were clearly exposed. Further than this, Prof. LINDSTRÖM communicated to me the noteworthy fact that his predecessor, the late Prof. ANGELIN, had discovered some of these fossils in Gotland, many years since, and, what is still more important, that he recognised their true characters. In a letter to Prof. LINDSTRÖM dated Wisby, June 19, 1864, ANGELIN remarks as follows: »De små haklika partierna som du i stor mängd trakterade mig med från Vattenfallet vid Wisby, och som, för öfrigt, anträffas öfverallt på Gotland — äro lemningar af Annelider — käkar deraf och hudbeklädnad.» »The small hooked fragments from the

waterfall near Wisby, of which you furnished me with great numbers, and which, moreover, are met with throughout Gotland, are the remains of Annelids — the Jaws and cutaneous coverings.» — Professor ANGELIN had also figured two or three examples of these minute jaws in one of the quarto plates of fossils which had been prepared for the press, but unfortunately were never published, so that there can be no doubt that the objects which he refers to in his letter to LINDSTRÖM were really the remains of these animals. Prof. LINDSTRÖM writes me that he has been unable to discover, amongst the papers left by ANGELIN, any descriptions whatever relating to these figured specimens. The fact however is clearly established, that to the late Prof. ANGELIN is due the credit of being the first to recognize the true characters of these small fossil jaws, and it gives me great pleasure to be able to bring forward publicly this fresh proof of the knowledge and discernment of this able palæontologist.

On reaching Gotland I found, on my first searching expedition, some few portions of the minute black jaws in strata of blue marly shales exposed in the bed of a small stream just outside the town of Wisby. There were also traces of them in the cliffs to the south of Wisby, but it was not until reaching an exposure of low shelving rock on the flat shores between Klintehamn and Fröjel that I met with them in any abundance. The rock at this place is a blueish flaggy calcareous shale, frequently fissile. The jaws were more abundant in one particular thin bed, which contained besides numerous examples of Beyrichia and other species of Ostracoda, and a well marked species of Chonetes described and figured as Ch. cingulata by LINDSTRÖM in his paper on the Brachiopoda of Gotland in Öfvers. Vet. Ak. Förhandl. 1860 p. 374 fig. 19. At every stroke of the hammer, the fresh surfaces brought to view, displayed one or more specimens of the jaws, and I spent two days at this spot in breaking up and examining the fissile slabs strewn on the shore, so as to secure as complete a collection as possible of these minute fossils, for, though very numerous, a large proportion became fractured in the process of reducing the rocky matrix, and only occasionally could a perfect specimen be obtained. There is a striking resemblance in the petrological characters of these Fröjel beds and those of the Cincinnati group in Canada, which are similarly filled

with Annelid remains, and these animals appear to have favoured the soft muds of the sea bottom which are now hardened into calcareous shales and flags. I also noticed that many of the rock-surfaces are covered with irregular track-like markings which may have been produced by the burrowing of these creatures in the mud.

In addition to these specimens from Fröjel, I also obtained numerous others from a small quantity of decomposed shale from the neighbourhood of Wisby, which Prof. LINDSTRÖM very kindly gave me. This I carefully prepared by washing and sifting, and then examined with a strong lens. To my great satisfaction this material proved exceedingly rich in these small jaws, there was a great variety of forms, and they are preserved in such perfect condition, that their characters can be as readily studied as those of recent annelids.

In appearance the fossil annelid jaws from Gotland resemble, in every respect, those from the corresponding strata in North America and England; they are of a blackish tint, and the surface is smooth and polished. I have not been able definitely to determine the present chemical constitution of these small bodies, but it appears to consist of mineral components, in which carbonate of lime is absent, for nitric acid produces no effect on them. It is not improbable that the original chitin has been, in part at least, replaced by carbonaceous material.

These jaws are now scattered irregularly throughout the rock, entirely detached from each other; in no single instance have I discovered the different plates which constitute the jaw-apparatus of the animal in their natural relative positions, although this occurs in the case of the fossil Jurassic annelids from Solenhofen which have been described by Prof. EHLERS [Paleontographica Bd. 17 p. 145.] But though thus detached, these fossils give no indication of having suffered from abrasion and transport, and it seems to me that the disturbance in position which they have undergone may not improbably be attributed to the small ostracoda abounding in the same beds, which, by preying upon the soft parts of the annelid after its death, and thus consuming the muscles which held the jaws in position, rendered them liable to be separated from each other by the slightest movement of the water.

It is a curious circumstance that out of hundreds of examples of these detached jaws, I have not been able to detect a single specimen, which, from its form, can be referred to the so termed *under* jaws in the existing representatives of the order. And yet if we may judge from the close resemblance of many of the fossil forms to constituent portions of the *upper* jaw in the living forms, there seems good reason for supposing that the Silurian annelids also possessed the equivalent under, as well as the upper jaw plates. In existing species, the plates of the under jaw are frequently of a more calcareous composition than those of the upper, and thus would naturally have been supposed more likely to have been preserved than the mostly chitinous upper jaws; and such is really the case in those examples of annelids from Solenhofen, as stated by EHLERS [Palæontogr. Bd. 17 p. 149] who remarks that »The underjaw and its cutting piece are always best preserved, probably because these contain deposits of calcite»; whilst the chitinous upper jaws in the same specimens have disappeared in the fossilization, and are only known by the impressions which have remained. In the Silurian strata on the other hand, a somewhat reverse process appears to have taken place, for the chitinous *upper* jaw plates have been perfectly preserved, whilst there are no traces of the *under* jaws. It is true that the under jaws are frequently smaller, and also from their lighter tint, would be less conspicuous than the plates of the upper jaws, and consequently more liable to escape notice; but from the very close scrutiny which I bestowed on the material in which the upper jaws were so numerous, it is very improbable that any of the under jaws could have been present in it without being detected. Further, a similarly conspicuous absence of the under jaw plates also ocurred in the specimens from the English and Canadian Silurian, for amongst these, there was but a single form *Arabellites quadratus*, HINDE [Quart. Jour. Geol. Soc. Vol. 35 pl. 19 f. 14] which I referred to a portion of the under jaw, and this differs so much from the normal forms of the under jaws in existing annelids, and has, moreover, the same dark chitinous appearances characterizing the distinctive upper jaw plates, that I am now disposed to doubt the correctness of my former reference of it to an under jaw plate.

A glance at the forms represented on the plates will at once show how greatly these Gotland annelid remains resemble those from the Silurian and Devonian strata of North America and England, which I have described and figured in the Quarterly Journal of the Geological Society for 1879 and 1880. The majority of the specimens can be placed in the same species; others differ in small details of structure, whilst there are a few distinctive forms, which appear here for the first time. On the whole the Gotland examples are decidedly smaller than those from England and America. The largest specimen which I have discovered is scarcely 2 mm. in length, whilst the smallest jaw plates do not exceed 0,3 mm. On comparing the figures accompanying this paper, with those of my previous papers, it will be necessary to take into account the much larger scale to which the former have been drawn, for in order to convey a just idea of the relative dimensions, and to allow of adequate representation of the smaller forms, I have delineated them all on the same scale of 28 diameters. The Silurian Annelids, if one may judge from a comparison of their jaw plates with those of existing Errantia, would not have been more than 7 to 10 cm. in length, and thus perhaps of nearly corresponding dimensions, or, if anything, rather smaller, than the majority of the existing commoner forms of the order.

The freedom from the matrix, and the perfect preservation of these Gotland examples afford greater facilities for making a comparison with the jaw apparatus of existing annelids than could have been obtained from the American and English specimens, which had, as a rule, but one surface exposed. The Gotland examples exhibit both the upper and under surfaces, so that it is possible to ascertain the characters of both in the same specimen.

Scarcely a doubt can be entertained that these various fossil jaw plates, with one or two exceptions, belonged to Annelids whose nearest representatives in the existing seas are comprised in the family of the Eunicea. Such is the opinion which Prof. EHLERS, the principal authority on living Annelids, has communicated to me after an examination of some of the Gotland specimens which I submitted to him. This family of the Nereidea, as is well known, is distinguished from the other allied families of the order by the possession of a jaw armature consisting of several distinct chitinous

toothed plates of different forms and sizes, attached to the jaw-sac in close proximity to each other. Prof. EHLERS, in his exhaustive monograph on the »Borstenwürmer», has divided this family into two principal groups, in one of which, the *Eunicea labidognatha*, the separate plates in the half of each upper jaw are very unequally formed, and so placed with regard to each other, that in the resting position, the smaller pieces are arranged in a semicircle round the larger; whilst in the other group, the *Eunicea prionognatha*, the exsertile jaw-plates in the half of each upper jaw are more or less similar and arranged in a row behind each other. To some of the principal jaw plates in existing annelids, distinctive names have been assigned by EHLERS and CLAPARÈDE, but at present, so far as I am aware, no equivalent English terms for these organs have been used, and I propose therefore to employ the following corresponding terms; (1) Supports = *Träger*, EHLERS; *Support*, CLAPARÈDE. (2) Pincers = *Zange* EHLERS; *Pince*, CLAP. (3) Large dental plate = *Zahnstücke*, EHLERS; *Pièce dentaire*, CLAP. (4) Paragnaths = *Säge-platten* EHLERS: *Paragnathes*, CLAP.

The resemblance of many of the fossil specimens to these distinctive jaw plates is so clear, that there is no difficulty in determining their relative positions in the jaw apparatus, but at the same time it is quite impracticable to determine, with any reasonable approximation, the particular detached plates which were associated together to complete the jaws of the fossil annelid. This difficulty is at once manifest if an attempt is made for example, to reconstruct from these detached fossil jaw plates, the jaw armature of an annelid resembling the existing genus *Eunice*. We find that there are several of the fossil plates closely resembling the large dental plate and also the paragnaths of the upper jaw, but the halves of the under jaw are wanting, and there are no fossil jaws to correspond closely to the supports and the pincers of the upper jaw, which are present in an existing *Eunice*. It is possible that these missing pieces may have been originally present, though they have not yet been discovered, but considering the numbers of the other plates which are present, the absence of these particular portions renders it very uncertain whether the jaw apparatus of these Silurian annelids was composed of as many plates as that of the existing genera to which they appear nearest allied. Until some complete forms

are discovered, showing the constituent plates of the jaw-armature in their relative positions, which, judging from my own experience, seems at present unlikely, we shall have to be content with a description of these detached jaw plates based upon their nearest resemblances to those of existing forms. The references to the genera will have to be regarded as merely provisional, until further discoveries allow a more correct classification to be adopted. Notwithstanding this hindrance to a satisfactory arrangement, the number and variety of these fossil jaws plainly indicate that this family of Annelids had attained to as great a development in the Silurian period, as in the present time, and although their remains have been so rarely discovered in the periods intervening between the Silurian and the present, the resemblance of these microscopic fossils to the chitinous jaws of recent forms is sufficiently clear to establish a genetic relationship between them.

Annelida Polychæta.

Genus EUNICITES, EHLERS.

Eunicites simplex, HINDE. Pl. 1 f. 1—4.

1879. *Eunicites simplex*, HINDE. Quart. Jour. Geol. Soc. Vol. 35 p. 376. Pl. 19 f. 2.

These jaws have the form of simple elongated hooks, with rounded or obtuse basal ends, they gradually curve forwards and the extremities are blunted. There is a large, somewhat oval aperture at the proximal end for the insertion of the muscle; the jaw appears to be hollow quite to the point. In size these jaws vary between 0,51 and 1,44 mm. in length, and 0,1 and 0,3 mm. in width. Examples similar to these are present in the Canadian Silurian and the Carboniferous of Scotland. In general form these jaws approach closest to the pincers (Zange) of the existing genus *Eunice;* but they differ therefrom in the absence of an articulating surface at the proximal end, by which the pincers in the existing forms are connected with the supports. The specimens are not uncommon. I have only found them in material from Wisby.

Eunicites, sp. Pl. 1 fig. 5.

Small compressed spatula shaped bodies with rounded, somewhat inflated front margins, the proximal end hollow,

somewhat narrower than in front. The central portion in front is depressed. Length 0,67 mm.. width 0,18 mm. All the specimens are incomplete at the distal ends. The only portions of the jaw apparatus to which these small bodies can with any probability be referred are the Supports (Träger). They are comparatively abundant and very uniform in size.

Locality. Wisby; Fröjel.

Eunicites cristatus, HINDE. var. Pl. 1 fig. 6.

1879. *Arabellites cristatus,* HINDE. Quart. Jour. Geol. Soc. Vol. 35 p. 378. Pl. 19 f. 7.

Jaw consisting of a compressed, rudely triangular, hollow plate with a short obliquely extended shank, the upper or free surface is slightly concave; the free margin is furnished whith a series of about 12 rounded denticles of which the first is usually smaller than those immediately succeeding. Length 1,06, width 0,83 mm. In general form the examples resemble the Canadian species, but the denticles are relatively shorter. In my description of the Canadian examples I placed them under *Arabellites;* but a further study of existing species of *Arabella* and *Eunice* induces me to regard these and similar forms, in which the primary denticle of the jaw is not developed into a prominent hook, as more closely resembling the large dental plates (Zahnstücke) of *Eunice*, than of Arabella. All the examples met with belong to the right half of the jaw-sac.

Locality. Fröjel.

Eunicites hebes, n. Pl. 1 figs. 7, 8, 9.

Jaw plates elongate, slightly concave on the upper surface, widest at the anterior margin which is slightly incurved, straight or rounded and is extended to form a short blunted shank: the posterior extremity is obtusely rounded; the free edge carries a series of 13 to 15 rounded blunted denticles, which project but slightly from the border of the plate. Variable in size, a fairly large example is 0,96 mm. long by 0,54 wide; whilst a small example is only 0,4 by 0,24 mm. Figs. 7 and 8 are large dental plates of the left side, whilst fig. 9 belongs to the right side of the jaw-sac.

Locality. Wisby.

Eunicites contractus, n. Pl. 1. fig. 10.

Jaw plate somewhat crescentiform, with a slightly concave upper surface, the anterior margin slightly rounded and extended to a small pointed shank; the outer lateral margin curved in front, and then nearly straight to the blunted posterior extremity; the free margin is curved and is furnished with a series of 8 to 10 triangular blunted denticles, very irregular in size, the fourth in the series being the largest. Length 1,23, width 0,81 mm. This jaw is distinctly characterized from the preceding large dental plates by its relative shortness and more prominent denticles. Rare.

Locality. Fröjel.

Eunicites serrula, HINDE. Pl. 1, figs. 11, 12.

1880. *Staurocephalites serrula,* HINDE. Quart. Jour. Geol. Soc. Vol. 36 p. 376. Pl. 14, figs. 18—20.

Jaw plates oblong, flat or having the oblique anterior margin slightly incurved, widest in front and gradually diminishing towards the posterior end which is blunted or slightly truncate. The lateral margins usually straight; the free margin carries a regular series of triangular pointed denticles, 11 to 17 in number. A fairly large example is 1 mm., in length, and 0,35 mm. in width. Though generally smaller in size, the specimens correspond closely in form with the examples from the English Wenlock, which, in my former paper, I erroneously included in the genus *Staurocephalites;* I now regard them as more probably unpaired dental plates of Eunicites. They are fairly abundant.

Locality. Wisby and Fröjel.

Eunicites coronatus, HINDE. Plate 1, fig. 13.

1679. *Eunicites coronatus,* HINDE. Quart. J. G. Soc. Vol. 35 p. 381. Pl. 20, fig. 9.

Jaw semilunar in outline, consisting of a hollow arched plate, with a wide, open base next the jaw-sac, on the summit of the plate is a strong curved ridge, carrying a series of about 11 rounded blunted denticles. Length of fairly large example 1,36 mm., breadth 0,58 mm. The resemblance of these jaw plates to the paragnaths of the existing genus *Eunicea* is so close, that there is every probability they occupied a similar position in the jaw armature of the palæozoic forms.

The Gotland examples correspond closely with those from the Clinton series of Canada, and also with those from the Wenlock series of the West of England. The forms are abundant.

Locality. Wisby.

Eunicites coronatus, varieties a, b. c. Pl. 1, figs. 14, 15, 16.

Besides the very regularly formed examples of *E. coronatus*, there are other jaw plates evidently of the same character but differing in detail. It is just possible that they may be paragnaths of distinct species of Eunicites, but for the present I prefer to regard them as varietal forms of *E. coronatus.*

Var. a fig. 14. This form is less strongly arched, the greatest breadth is nearer one end, and the opposite end is more prolonged, than in *E. coronatus.* The primary denticle is missing, the three following are relatively large, triangular and blunt; these are succeeded by a series, 6 to 8 in number, of minute rounded denticles. Length 0,76; width 0,54 mm. This variety, in some respects, resembles the *Eunicites chiromorphus*, H. from the Clinton series of Canada.

Var. b. fig. 15. Jaw plate slightly arched, the basal portion somewhat prolonged and contracted; the ridge nearly straight and furnished with about 10 triangular blunted denticles of different sizes. Length of crest 1; width of plate 0,83 mm.

Var. c. fig. 16. Jaw plate triangular, slightly arched, the base is extended into a curved shank, the crest has a regular series of triangular denticles 7 in number. Length of crest 0,58 mm., width 0,67 mm.

The above varieties are all rare forms.

Locality. Wisby and Fröjel.

Eunicites pusillus, n. Plate 1, figs. 17—20.

Jaw plates diminutive, hollow and arched; triangular in outline and carrying 7 to 10 denticles on the free margins. In one form (fig. 18) the plate is strongly arched and there is a conical projecting denticle at each end of the toothed crest. These jaw plates are evidently paragnaths and differ from *E. coronatus*, principally in their smaller proportions and contracted bases. The length and breadth are about

equal, and vary in different specimens between 0,2 and 0,5 mm. The forms are rare.

Locality. Wisby and Fröjel.

Genus ŒNONITES, HINDE.

Œnonites aspersus, HINDE. Pl. 1, figs. 21, 22, 22a.

1880. *Oenonites aspersus*, HINDE. Quart. Jour. Geol. Soc. Vol. 36 p. 373. Pl. 14 figs. 7, 8.

The jaw plate is rudely oblong, flat or slightly concave on the free surface, with a prominent conical tooth in front, which is more or less oblique to the plane of the jaw plate. The posterior extremity is obliquely truncate with a spoon-shaped central depression and a small lateral flange. The outer lateral margin is curved in front and then becomes nearly straight. The inner or free lateral margin is nearly straight, and its edge carries a closely set series of minute pointed crenulations, occasionally the anterior two or three are somewhat larger than the rest of the series. The under surface is convex and there is an elongated aperture near the posterior end for the insertion of the muscle. The jaw appears to be completely hollow quite to the base of the front tooth. A large specimen is 1,84 by 0,54 mm. and the smaller examples are about half the dimensions of the larger. The specimens are numerous, and they closely correspond with the forms from the English Wenlock and Ludlow beds, but in these latter, the posterior flange appears to have been broken off.

Locality. Wisby and Fröjel.

Œnonites major, HINDE. Plate 1, figs. 23, 24.

1879. *Eunicites major*, HINDE. Quart. Jour. Geol. Soc. Vol. 35 p. 374. Pl. 18 f. 1.

Jaw oblong to triangular in outline, widest in the central portion; tho upper or free surface concave, the anterior extremity incurved and terminating with a prominent curved hook, the posterior extremity obtuse, the outer lateral margin somewhat inflated, curved anteriorly; a slight jutting out elbow in the centre from which the margin extends nearly straight to the posterior end. The free lateral margin is nearly straight, and is provided with a series of stout triangular denticles,

directed backwards; the anterior denticles are frequently blunted by wear. The under surface of the jaw exhibits a deep angular cavity extending from the posterior end to about two-thirds of its length; the front portion is arched over. The examples are abundant. A large specimen is 2 mm. in length; an average specimen measures 1,3 by 0,47 mm. This jaw is similar to forms from the Cincinnati series of Toronto, and the English Wenlock, which, judging from the under surface of the specimens, I had placed under *Eunicites*, but these perfectly free Gotland specimens appear to resemble closer the jaws of the existing Oenone.

Locality. Wisby.

Œnonites naviformis, HINDE. Pl. 2, figs. 25—30.

1880. *Oenonites naviformis*, HINDE. Quart. Jour. Geol. Soc. Vol. 36 p. 372. Pl. 14 f. 3.

Jaw oblong or somewhat triangular in outline, depressed in the centre; the anterior margin slightly incurved and terminating in a prominent, pointed, conical tooth, which is more or less oblique to the jaw-plate; the front part of the outer lateral margin is rounded, in the centre is a small blunted process and then the margin tapers to the obtuse or truncate posterior extremity. The inner or free lateral margin is straight or slightly arched, and carries a series of small denticles, 10 to 13 in number. The under surface of the jaw is similar to that of *Oe. major*, and has a deep furrow extending for two-thirds of its length, whilst the front portion is arched over. The forms are all minute and vary between 0,47 and 0,76 mm. in length and about 0,2 mm. in width.

Locality. Wisby.

Œnonites curvidens, HINDE. Plate 2, figs. 31, 32.

1879. *Oenonites curvidens*, HINDE. Quart. Jour. Geol. Soc. Vol. 35 p. 376. Pl. 18 f. 7.

Jaw triangular in outline; upper surface slightly concave, the anterior margin incurved and with a sharply pointed conical tooth oblique to the jaw plate. The outer lateral margin is curved in front; in the central portion is an inflated, obliquely directed, process; posterior to this the margin has an open curve, and then becomes nearly straight to the obtuse extremity of the jaw. The free lateral margin is nearly straight and carries about 14 conical denticles. Length 0,8; width

0,29 mm. This form differs from the preceding mainly in the more prominent lateral projection and the tapering of the posterior end of the plate. The Gotland examples are all smaller than the type form from the Cincinnati series at Toronto.

Locality. Wisby.

Œnonites parvulus, n. Plate 2, fig. 33.

Jaw elongate; narrow, compressed, the anterior margin has a pointed conical tooth nearly in the same plane with the jaw-plate; the outer lateral margin is sligthly curved, the inner or free margin is straight and has about 14 denticles. The posterior end is obtuse. The under surface next the jaw-sac has a long open furrow. Length 0,49; width 0,1 mm. A rare form.

Locality. Wisby.

Œnonites radula, n. Plate 2, figs. 34, 34 a.

Jaw plate triangular in outline, the upper surface slightly concave, the upper portion of the outer margin is curved and extends forwards in a conical pointed tooth, which is bent inwards. The centre of the outer margin is acutely pointed, from this to the pointed extremity the margin is straight. The free margin is nearly straight, and has a series of 12 to 14 minute conical denticles. The under surface has a deep open hollow extending for nearly two-thirds of its length. An average specimen is 0,81 mm. long, and 0,38 wide. The triangular form of the plate readily distinguishes this from any of the preceding forms. The examples are not uncommon.

Variety cristula. Plate 2, fig. 35.

This differs from the preceding in possessing a projecting flange in the lower half of the jaw and the denticles spring from the edge of a low vertical crest. Its proportions are similar to the preceding.

Locality. Wisby and Fröjel.

Œnonites securis, n. Plate 2, fig. 36.

Jaw plate roughly triangular in outline, the upper surface is nearly plane, the front portion is curved and continued into an upward projecting shank; the anterior tooth curved; the free margin has a series of 10 to 14 minute conical denticles; at the posterior extremity it is slightly curved

and has a smooth edge. Length of toothed edge 0,63 mm.; breadth 0,45 mm. Rare.

Variety: basalis. Pl. 2, fig. 37. In this form the shank is widely expanded, there is also a slight flange in front of the denticles and these are carried on a low vertical crest. There are also some examples with the dentated crest and flange and with the shank narrow, similar to that of fig. 36.

Locality. Wisby.

Œnonites? spiniger, n. Plate 2, figs. 38—41, 41 a.

Small triangular plates, with straight or slightly curved free margins, furnished with from 5 to 9 conical denticles. A robust spine springs from the lower portion of the plate and projects obliquely outwards. Both right and left plates are present. The length of the toothed margin varies between 0,38 and 0,54 mm. and the width of the plate between 0,3 and 0,45 mm. The examples are rare. This form of jaw is very distinct from any other of these fossils, nor have I met with any recent annelid jaws with which it can be compared; consequently I have placed it only provisionally under Oenonites.

Locality. Wisby.

Genus ARABELLITES, HINDE.

Arabellites hamatus, HINDE. Pl. 2, figs. 42, 43, 44.

1879. *Arabellites hamatus,* HINDE. Quart. Jour. Geol. Soc. Vol. 35, p. 377. Pl. 18, f. 12.

The main portion of the jaw plate is oblong and prolonged forwards into a robust curved hook which is directed obliquely inwards. The posterior extremity is obliquely truncate with a knob-like elevation near the outer edge and in front of this is a spoon-shaped depression; the margin is smooth and rounded, and appears to have rested on the upper surface of the underlying 'Supports'. In some examples there is a slight flange in front of the denticles. The outer lateral margin is gently curved, smooth and slightly inflated. The free lateral surface is nearly straight and is furnished with from 10 to 13 minute conical denticles, at its proximal end the edge is smooth. The under surface has an obliquely ovate aperture near its posterior end; the jaw is hollow quite

to the anterior hook, but the cavity is inclosed by a flattened convex plate. The specimens vary between 0,7 and 1,1 mm. in length, and from 0,2 to 0,3 mm. in width. They vary slightly from the typical example of the species from the Cincinnati series of Canada, but the variations are not greater than those which are present in some of the Canadian specimens. There can be no doubt of the similarity of these jaws to the »pincers» in the existing *Arabella*. The jaws which were figured in the unpublished plate of silurian fossils, by Prof. ANGELIN (figs. 20 to 23) appear to belong to this species. The examples are somewhat rare.

Locality. Wisby and Fröjel.

Arabellites fastigiatus, n. Pl. 2, fig. 45.

This jaw is in outline similar to the preceding; but it possesses a strong ridge which extends from the posterior extremity across the plate, and is then continued forwards on the outer lateral margin quite to the end of the hook. In front of the ridge, and continuous with it, is a rounded furrow. The free margin has a series of 12 denticles, the anterior four are compressed, triangular and spring from the margin of the plate, the next following are on the edge of a small vertical ridge. The under surface is concave and open as far as the junction of the hook with the plate. Length 1,28 mm.; width 0.4 m. m. The form is rare; but both right and left jaws are present, and alike exhibit the distinctive feature of the longitudinal ridge and furrow.

Locality. Wisby.

Arabellites contractus, HINDE. Pl. 2, figs. 46, 46 a.

180. *Arabellites spicatus, var. contractus,* HINDE. Quart. Jour. Geol. Soc. Vol. 36, p. 375. Pl. 14, f. 14, 15.

Jaw plate oblong, convex, widest in front and extended forwards into a stout hook which is obliquely curved inwards. The posterior margin obliquely truncate with a spoon shaped depression close to the dental ridge. The outer lateral margin gently curved and slightly inflated. There are about 10 recurved conical denticles on the edge of a slight ridge which is nearly vertical to the plate. The under surface exhibits in the lower half a wide open concavity, bordered by convex ridges; the front portion is arched over and convex. Total length 1,1; width 0,57 mm. The specimens very closely re-

semble the type forms from the English Wenlock. It is somewhat rare and all the specimens which I have met with are left forms.

Locality. Wisby.

Arabellites spicatus, HINDE. Plate 2, figs. 47—49.

1880. *Arabellites spicatus,* HINDE. Quart. Journ. Geol. Soc. Vol. 36 p. 374. Pl. 14 f. 13.

Jaw plate sub-rhomboidal, longitudinally concave and extended forwards into a stout obliquely curved hook; the exterior lateral margin is elevated and thickened; the posterior margin incurved; on the free margin is a thickened ridge extending backwards beyond the main portion of the plate, and supporting on its edge a series of 10 stout conical recurved denticles, which are nearly at right angles with the plate. The under surface of the plate is hollow and open as far as the commencement of the hook. A large specimen is 1,3 mm. by 0,57 wide, whilst a small one measures 0,6 by 0,36 mm. in width. It is a rare form; I have only found specimens belonging to the right side of the jaw apparatus. In the Gotland examples, the spur which projects from the posterior margin of the Wenlock shale forms is not developed, but in other respects the similarity to the typical forms is very close. This jaw appears to represent the »pincers», though there is no indication of any attachment to supports below, as in the normal types of the existing genus Arabella.

Locality. Wisby.

Arabellites anglicus, HINDE. Plate 2 figs. 50, 50a, 51.

1880. *Arabellites anglicus,* HINDE. Quart. Jour. Geol. Soc. Vol. 36 p. 275 Pl. 14 fig. 17,

Jaw plate elongated, the upper surface longitudinally concave; the front margin curves inwards and terminates in a stout curved hook which is oblique to the plate. There is a stout, blunted shank which projects obliquely downwards and outwards, below this the lateral margin curves to the truncated posterior extremity. The free margin immediately below the hook is deeply curved and minutely crenulated, it then becomes sligthly arched and carries a series of 8 stout conical denticles. The under surface has an elongated curved aperture near the posterior end; in front of this the under

surface is convex. The length in different examples varies between 0,81 mm. and 1,3 mm., and the width between 0,45 and 0,67. The examples are abundant, but they are all left forms. These jaws appear to correspond with the large dental plate (Zahnstücke) of the existing genus Arabella. The similarity is very close to the type specimens from the English Wenlock and Ludlow.

Locality. Wisby and Fröjel.

Arabellites arcuatus, HINDE. Plate 2 figs. 52, 52a.

1879. *Arabellites similis var. arcuatus.* HINDE. Quart. Jour. Geol. Soc. Vol. 35 p. 385. Pl. 20 fig. 20.

Jaw crescentiform, the upper surface slightly concave; an oblique pointed shank extends to below the middle of the plate; the lower portion of the exterior lateral margin is slightly curved and with a linear ridge, the front portion of the free lateral margin is arched inwards; there is a single prominent conical tooth which is preceded by two minute denticles and followed by a series of 8 to 10 conical pointed recurved ones. The under surface has an elongated curved aperture similar to that of the preceding form, in front of this, the surface is convex. Length 0,58 mm. by 0,29 mm. in width. This form is very rare; it agrees closely with the type, from the Devonian of Canada, but it is much smaller.

Locality. Wisby.

Arabellites angustus, n. Plate 2 fig. 53.

Jaw narrow, elongate; the upper surface nearly flat; the anterior margin thickened, incurved, and prolonged downwards into a short blunted shank; below this, the margin is curved to the obtuse posterior extremity. In front is a stout conical tooth, succeeded by two minute denticles, then follows a second prominent tooth, below which, to the posterior extremity the slightly curved margin has 10 closely set minute conical denticles. The under surface has a narrow aperture extending from the lower end as far as the shank. Length 0,63 mm., width 0,31 mm. This jaw is of the same character as the preceding, but it is much narrower, and the shank is shorter.

Locality. Wisby.

Arabellites concinnus, n, Pl. 3, fig. 54.

Jaw triangular in outline, concave in the central portion; the front margin is thickened and extended obliquely downwards into a short curved shank, below this the lateral margin is gently curved. The free lateral margin is arched and has the edge curved over below; it carries a series of 12 conical pointed recurved denticles, the three anterior of these are in the same plane as the plate; those following on the curved edge are at right angles to it. The under surface is hollow nearly the entire length of the jaw. Length 0,63 mm. width 0,29 mm. It is a rare form, and differs from the preceding principally in the character and position of the denticles.

Locality. Wisby.

Arabellites ferox, n. Pl. 3, figs. 55, 55a.

Compare *Arabellites crenulatus.* HINDE. Quart. Jour. Geol. Soc. Vol. 35 p. 379. Pl. 19, fig. 9.

Jaw plate triangular with a stout, nearly straight shank projecting at right angles from the anterior margin. The end of this shank, in perfect examples, has a slight incurved process. The outer lateral margin is nearly straight, on the free margin are five very prominent claw-shaped denticles, between which are similar smaller ones. The under surface of the plate is hollow. Length along the free margin 0,65 mm.; width to the end of the shank 0,6 mm. This jaw is of the same character as *A. crenulatus* from the Cincinnati series of Toronto, and differs therefrom mainly in the form and position of the denticles.

There are other jaws evidently of the same character as the above, but differing in detail sufficiently to be regarded as varieties. It seems probable that these minute forms correspond to the smaller dental plates (Säge-platten) of the existing genus Arabella.

var. a. Pl. 3, fig. 56. In this form the shank is conical and slightly curved; the anterior tooth is relatively very long, straight, conical and pointed, there is a minute denticle in front and four behind it, the lower part of the jaw plate is wanting.

var. b. Pl. 3, fig. 57. In this variety the shank is short and slightly curved inwards, the free margin is slightly arched and carries 7 conical, pointed, slightly curved denticles. The length and breadth nearly equal, about 0,33 mm.. This variety

resembles somewhat *A. obtusus* from the Wenlock shales (Q. Jour. Geol. Soc. Vol, 36. Pl. 14, fig. 16) but differs in the form of the denticles.

var. c. Pl. 3, fig. 58. The jaw plate triangular, with a nearly flat upper surface; the shank is small and incurved. The free margin has three blunted denticles, followed, after a short interval, by 7 very minute ones. Length 0,45 mm.; width 0,31 mm.

Locality. Wisby.

Arabellites uncinatus, n. Plate 3, figs. 59—63.

Jaws consisting of a stout, simple, conical or compressed, straight or curved hook, with an elongated, narrow, hollow base, at right angles to the direction of the hook. The hook itself is hollow, and continuous with the cavity inclosed by the base. The base is only extended in the direction towards which the hook is curved. In one specimen (fig. 63) there is a small projecting spur extending below the hook. The hook itself varies in length between 0,24 and 0,7 mm., whilst the base in the different specimens is generally a little longer than the hook; in one specimen however it is half as long again, and measures 1 mm. The examples are numerous.

This jaw resembles in form, though relatively much larger, the distal jaw in the mouth armature of *Arabella (Oenone) maculata*, EDWARDS sp.; a similar form also occurs in existing species of Oenone and allied genera. In the jaw apparatus of *Halla parthenopeia,* DELLE CH. (of which a specimen has been kindly presented to me by Prof. EHLERS) the terminal jaw of the series consists of a simple hook (with but a slightly extended base), similar to these fossil forms.

Locality. Wisby.

Genus LUMBRICONEREITES EHLERS.

Lumbriconereites obliquus, EICHWALD sp. Pl. 3, figs. 64—67.

1854. *Sphagodus* obliquus, EICHWALD. Bull. de la Soc. Imp. d. Nat. de Moscou p. 110, Taf. 2 f. 10.

1856. *Aulacodus obliquus,* PANDER. Monog. d. foss. Fische d. Sil. Sys. d. Russ. Balt. Gouv. p. 72, Taf. 4 f. 16 a, b, c, d.

1879. *Eunicites contortus*, HINDE. Quart. Jour. Geol. Soc. Vol. 35 p. 375. Pl. 18, fig. 4.

1879. *Eunicites clintonensis.* HINDE. Ib. p. 381. Pl. 19, f. 21.

1880. *Lumbriconereites basalis,* HINDE. Ib. Vol. 36, p. 376.

Jaws triangular in outline, consisting of a basal flange with an oblique ridge, on the summit of which are the denticles. The right and left jaw plates differ from each other. In the left forms, the oblique tooth-bearing ridge springs from the outer lateral margin of the basal plate, which is only exposed on the inner side of the ridge. This basal plate is concave immediately beneath the oblique ridge, and has a stout upward projecting shank in the middle of its length, and below this, the plate rapidly contracts to the posterior end. The oblique dental ridge is curved in front and then becomes nearly straight, it has a series of 15 to 18 denticles, of which the anterior two or three are more prominent and curve inwards, those following are rounded or conical and directed backwards. The anterior denticles are frequently worn down so that they appear as mere hollow stumps.

In the right jaw plate the basal flange is wider, nearly flat, and extends on both sides of the toothed ridge. The central portion of the inner margin has a thickened prominence which, however, does not project into a shank as in the left jaw plate. The dental ridge is nearly vertical to the basal flange, and extends longitudinally down it. The character and number of the denticles correspond with those of the left jaw plate. The under surface of both right and left jaws has the anterior portion arched over and gently convex, below this to the posterior extremity the jaw is hollow and open, so that even the hollow bases of the denticles can be distinguished. In the left jaw plate the under surface of the shank also exhibits a concavity. These jaws are from 1,7 to 2,1 mm. in length, and about 0,7 mm. in extreme width. They are very abundant.

Though these right and left jaws occur quite detached from each other, I regard them as belonging to the same species from the fact of their correspondence in dimensions and in the character of the denticles whilst the differences in the form of the basal flange and the position on it of the dental ridge, are limited to the right and left forms respectively. The perfect preservation of these Gotland specimens has enabled me to determine, that in some of the Canadian forms but partially exposed on the rock surface, the toothed ridge was supported on a basal flange; whereas I had regarded it as the edge of the jaw plate itself, and thus placed these forms

under *Eunicites*. The resemblance of the figures given by PANDER of the *Sphagodus obliquus* of EICHWALD to the Gotland forms, when viewed in a certain position, leaves no doubt in my mind that the Gotland specimens are similar to this species, which was obtained from the Silurian strata of the Isle of Oesel, and referred somewhat doubtfully by PANDER to fish teeth. Some examples also from the English Wenlock which I placed under *Lumbriconereites basalis*, I now find properly to belong to this species, but the original type of *L. basalis* from the Clinton series of Canada is a much larger form and the size and position of its anterior tooth lead me to regard it as belonging to a different species.

Locality. Wisby and Fröjel.

Lumbriconereites perdentatus, HINDE. Pl. 3, figs. 68—71.

1879. *Eunicites perdentatus,* HINDE. Quart. Jour. Geol. Soc. Vol. 35 p. 375. Pl. 18. fig. 6.

Jaws minute elongate, in general form resembling the preceding species, but with a less development of the basal flange, which, in the right jaw plates, is limited to the lower half of the jaw. The dental ridge is slightly curved and has from 14 to 17 denticles, the anterior are larger, and, in some examples, acutely pointed; the following ones are conical and directed backwards. As a rule the jaws belonging to the right half are larger than those of the left half of the jaw apparatus. An average example is 0,65 mm. length by 0,25 mm. in width. The Gotland specimens are smaller than the type from the Cincinnati series of Toronto, but so far as I can determine from the Canadian forms, which are only partially exposed, they otherwise correspond. From the preceding species they differ in the character of the basal flange and in their much smaller dimensions.

Locality. Wisby.

Lumbriconereites spatiosus, n. Plate 3, figs. 72, 73, 73a.

Jaw subrhomboidal in outline, with a wide subquadrate, convex basal flange, which is exposed on both sides of the dental ridge. On the outer margin the flange projects upwards as a short spine, below this it runs nearly straight to the extreme posterior end of the jaw. The inner margin of the flange only extends for about two thirds of the length of the jaw, and is then obliquely truncate. The toothed ridge has

a slight curve both in front and at the lower end, it traverses the flange in a diagonal direction. There are from 14 to 17 denticles, the three anterior are larger, more rounded and blunter than those succeeding, which, in some specimens, are acutely pointed. The under surface exhibits a deep hollow, except in front where it is arched over. Both right and left jaws are present and the two halves differ very slightly from each other. An average example is 1 mm. in length and 0,56 mm. in width. The specimens are numerous.

Locality. Wisby.

Lumbriconereites falciformis, n. Pl. 3, figs. 74—77.

Under this term I include a small group of jaws which agree in possessing a curved or nearly straight toothed ridge, and a small straight or curved shank, which is either at right angles or oblique to the ridge. The under surface, except the shank, is usually hollow. It is probable that they are secondary dental plates (Säge-platten) of the jaw apparatus, and belong to more than one species.

Var. a, fig. 74. This form has a conical shank which projects, nearly at right angles, from the anterior of the toothed ridge. The ridge is slightly curved, triangular in section; on its crest are 8 to 10 denticles; the anterior ones are worn down and blunted, the following are conical, acute, and directed backwards. Length 0,85 mm.; breadth, to the end of the shank, 0,67. Rare.

Var. b, fig. 76. The shank is diminutive and curved, the toothed ridge curves completely over, there are about 13 denticles, those in front are minute and blunted, whilst those at the extremity are conical and projecting. Length 0,54; width 0,3 mm.

Var. c, fig. 77. The shank is elongated, rod-shaped, and at right angles to the triangular jaw plate; the toothed ridge is depressed; there are 9 denticles, the first two larger and more blunted than the following, which are conical and directed backwards. Length 0,38; width 0,31 mm.

Var. d, fig. 75. In this form the shank projects obliquely; the toothed ridge is gently curved and there is a series of rounded denticles on its crest, 10 to 14 in number. Length 0,51; width 0,225 mm.

Locality. All these varieties are from Wisby and they are very rare.

In the subjoined list of the forms herein described and figured, I have indicated by marks in the different columns, those forms which also occur in the Wenlock and Ludlow series of the West of England and in the Cincinnati, Clinton and Devonian strata of Canada. From this list it will be seen that of the 41 different forms from Gotland, there are 15 which also occur either in England or Canada. In the English Wenlock are 9 forms and in the Ludlow 2, which are common to Gotland. In the Cincinnati series of Canada, there are 6 forms which occur in Gotland, and two of these are also common to the English Wenlock. In the Clinton series of Canada are found 4 of the Gotland forms, whilst a single form is common to the Devonian of Canada. As a rule it may be stated that the jaws which are also present in England and Canada, are, with one or two exceptions, the most abundant forms in Gotland, whilst those which are limited to Gotland are of rare occurrence. From the examples figured, some idea may be formed of the abundance and variety of the errant annelids in the Silurian seas, particularly when it is remembered that these jaws have all been obtained from the surface of a few square metres of rock at Fröjel and from about a kilogramme of decomposed shale from Wisby.

		Gotland.	England.		Canada.		
		Silurian.	Wenlock.	Ludlow.	Cincin.	Clinton.	Devon.
1	Eunicites simplex	×			×		
2	» sp	×					
3	» cristatus	×			×		
4	» hebes	×					
5	» contractus	×					
6	» serrula	×	×				
7	» coronatus	×	×			×	
8	» » var. a.	×					
9	» » var. b.	×					
10	» » var. c.	×					
11	» pusillus	×					
12	Oenonites aspersus	×	×	×			
13	» major	×	×		×	×	
14	» naviformis	×	×				
15	» curvidens	×			×		
16	» parvulus	×					
17	» radula	×					
18	» » var. cristula	×					
19	» securis	×					
20	» » var. basalis	×					
21	»? spiniger	×					
22	Arabellites hamatus	×			×		
23	» fastigiatus	×					
24	» contractus	×	×				
25	» spicatus	×	×				
26	» anglicus	×	×	×			
27	» arcuatus	×					×
28	» angustus	×					
29	» concinnus	×					
30	» ferox	×					
31	» » var. a.	×					
32	» » var b.	×					
33	» » var c.	×					
34	» uncinatus	×					
35	Lumbriconereites obliquus	×	×		×	×	
36	» perdentatus	×				×	
37	» spatiosus	×					
38	» falciformis var. a.	×					
39	» » var. b.	×					
40	» » var. c.	×					
41	» » var. d.	×					

Explanation of the plates.

All the figures have been drawn by means of the Camera lucida and to the same scale of 28 diameters.

Plate I.

Fig. 1—4. Eunicites simplex, H. Pincers?
» 5. » sp. Support?
» 6. » cristatus, H. Large dental plate of the right side.
» 7, 8. » hebes, H. Left form of large dental plate.
» 9. The same. Dental plate of the left side of jaw apparatus.
» 10. Eunicites contractus, H. Left dental plate.
» 11, 12. » serrula, H. Unpaired dental plates.
» 13. » coronatus. H. Paragnath.
» 14. » » var. a. Paragnath.
» 15. » » var. b. Paragnath.
» 16. » » var. c. Paragnath.
» 17—20. » pusillus, H. Paragnath.
» 21. Oenonites aspersus, H. Jaw plate of the left side.
» 22. The same. »Right» jaw plate, upper surface.
» 22 a. The same. Under surface of the same, showing the aperture for the insertion of the muscle.
» 23. Œnonites major, H. »Left» jaw plate; upper surface.
» 24. The same. Under surface.

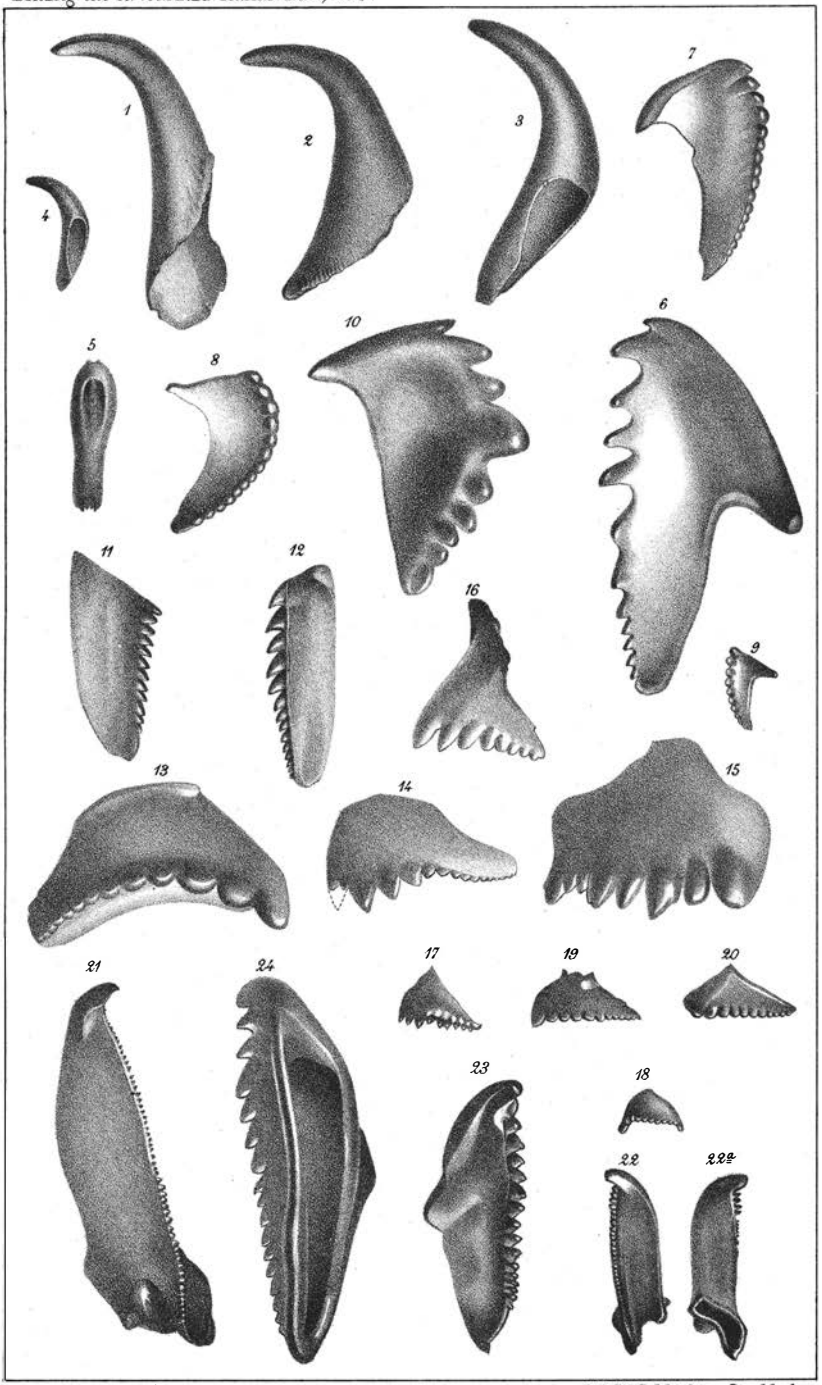
Plate II.

Fig. 25. Œnonites naviformis, H. Left jaw showing upper surface.
» 26. The same. Under surface.
» 27. The same. »Right» jaw; upper surface.
» 28. The same. Left jaw; upper surface.
» 29, 29 a. The same. Upper and under surfaces of the same specimen.
» 30. The same. Jaw of the left half; upper surface.
» 31, 32. Œnonites curvidens, H. Jaws of the right half of the jaw-apparatus; showing the upper surfaces.
» 33. Œnonites parvulus, H. »Right» jaw; upper surface.
» 34, 34 a. » radula. Upper and under surfaces.
» 35. » radula, var cristula. Upper surface.
» 36. » securis, H. Jaw plate of left side; upper surface.
» 37. » » var. basalis. »Left» jaw-plate; upper surface.
» 38—40. »? spiniger, H. Right and left forms, showing the upper surface.
» 41, 41 a. The same. Upper and under surface of the same specimen.
» 42. Arabellites hamatus, H. Pincer of the left side. upper surface.

Fig. 43. The same. Under surface, showing the aperture for the insertion of the muscle.
" 44. The same. Pincer of the left side; upper surface.
" 45. Arabellites fastigiatus, H. Pincer of the right side.
" 46. Arabellites contractus, H. Pincer of the left side, upper surface.
" 46 a. The same. Under surface.
" 47. Arabellites spicatus, H. Pincer of the right side, upper surface.
" 48. The same. Under surface.
" 49. The same. Upper surface.
" 50. Arabellites anglicus, H. Large dental plate of the left side; upper surface.
" 50 a. The same. Under surface.
" 51. The same. Large dental plate of the left side; upper surface.
" 52. Arabellites arcuatus, H. Dental plate of the right side; upper surface.
" 52 a. The same. Under surface.
" 53. Arabellites angustus, H. Secondary dental plate of the left side; upper surface.

Plate III.

Fig. 54. Arabellites concinnus, H. Secondary dental plate of the right side; upper surface.
" 55. Arabellites ferox, H. Secondary dental plate of the left side; upper surface.
" 55 a. The same, Under surface.
" 56. The same, var. a. Upper surface.
" 57. The same, var. b. Upper surface.
" 58. The same var. c. Upper surface.
" 59—63. Arabellites uncinatus, H. Distal jaw plates.
" 64. Lumbriconereites obliquus, EICHWALD, sp. Large dental plate of the left side; upper surface.
" 65. The same. Large dental plate of the right side; upper surface.
" 66. The same. Under surface.
" 67. The same. Left dental plate; under surface.
" 68, 69. Lumbriconereites perdentatus, H. Large dental plates of the right side; upper surface.
" 70, 71. The same. Dental plates of the left side; upper surface.
" 72. Lumbriconereites spatiosus, H. Large dental plate of the left side; upper surface.
" 73. The same. Right dental plate; upper surface.
" 73 a. The same. Under surface.
" 74. Lumbriconereites falciformis, H. var. a. Secondary dental plate of the right side; upper surface.
" 75. The same, var a. Right dental plate; upper surface.
" 76. The same, var. b. Right dental plate; upper surface.
" 77. The same, var. c. Right dental plate; upper surface.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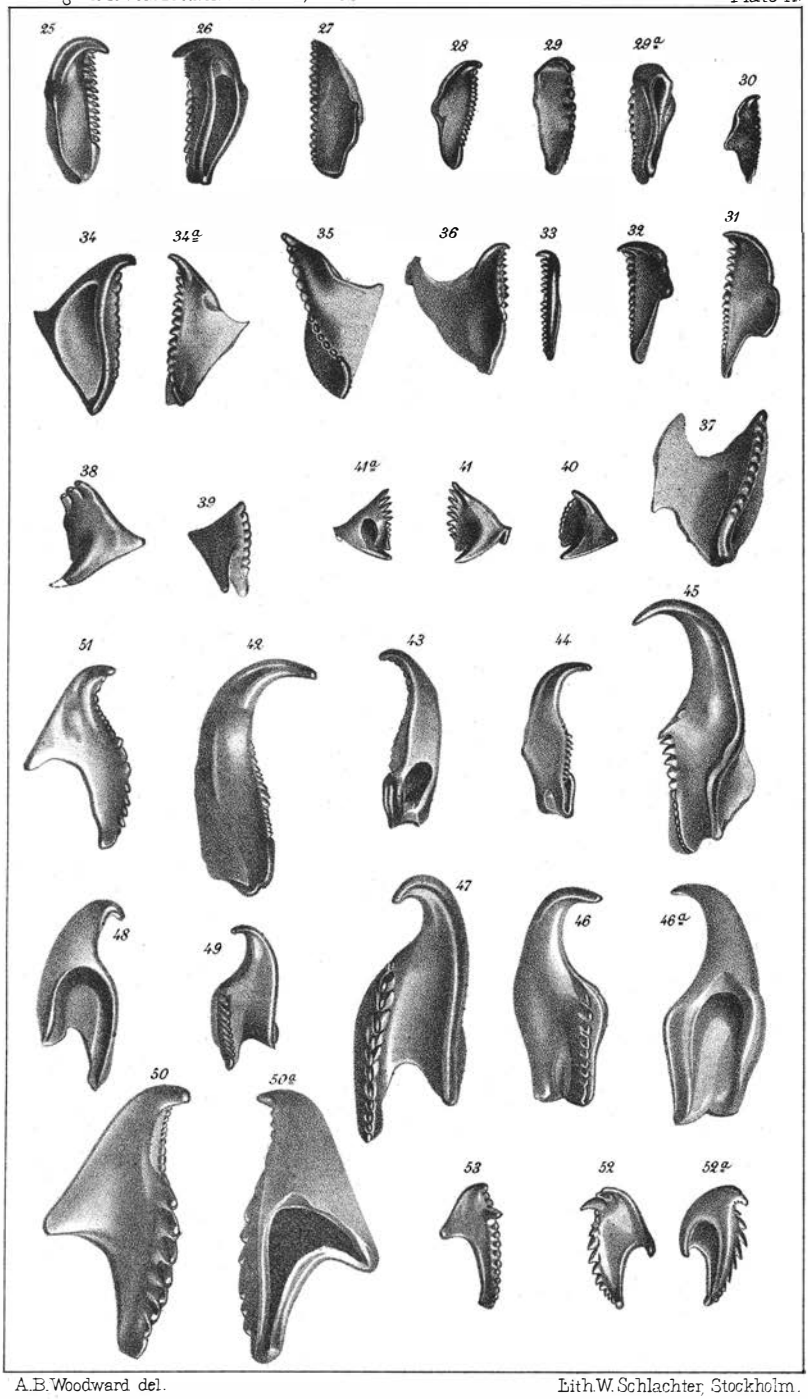
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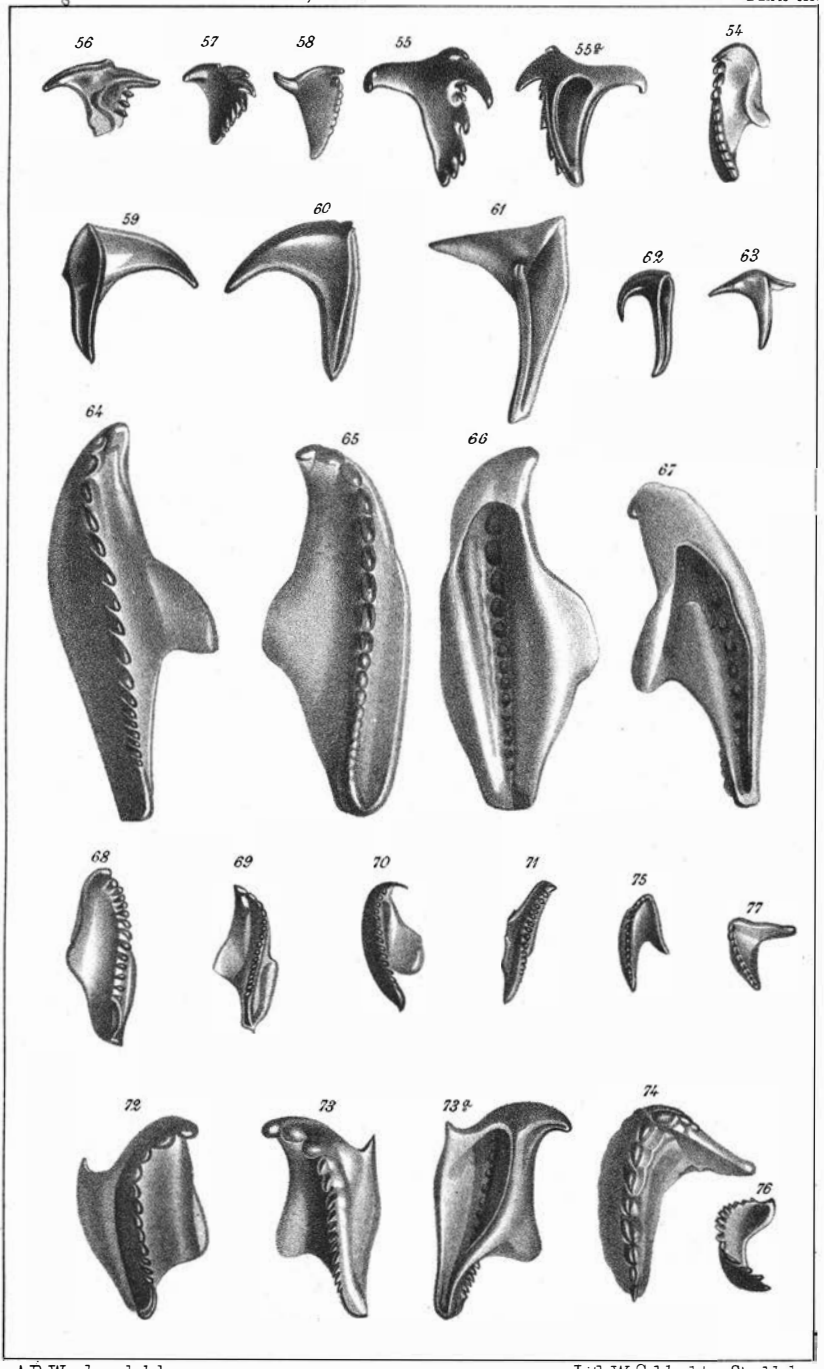
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