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Fossil Ensis species in the Netherlands

by

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After a revision of the recent *Ensis* species in Europe (van Urk, 1964) the fossil species of the Netherlands are being dealt with in the present paper. Actually, the species which are described here, have a wider distribution than is perhaps suggested by the title and thus the paper at the same time gives a survey of what may be found in the Scaldisien/Merxemien of the Netherlands and Belgium.

Otherwise the distribution is still very imperfectly known. *E. degrangei* (originally described from the Miocene near Bordeaux, France) and *E. rollei* have also a central European distribution. *E. complanatus* and *E. waltoniensis* are found in the Crag of Great Britain, while *E. arcuatus,* together with its var. *norvegica,* and *E. magnus* are known from Pleistocene layers in Scandinavia. It is almost certain, however, that there are more fossil species in Europe and I shall be grateful to anyone supplying me with such material.

The result of this work is mainly based on the two extensive collections of the Geologische Dienst, Haarlem (GD) (about 85 samples), and the Institut Royal des Sciences Naturelles, Brussels (IRSN) (234 samples). In addition material has been revised of the Natuurhistorisch Museum, Rotterdam (NHM), Rijksmuseum van Natuurlijke Historie, Leiden (RMNH), Comité ter Bestudering van de Nederlandse Molluskenfauna (Com., preserved at RMNH), British Museum (Natural History) (Department of Palaeontology), London

(BM), Naturhistorisches Museum (Geologisch-Paläontologische Abteilung), Vienna, and the Institut für Paläontologie der Rheinischen Friedrich-Wilhelm-Universität, Bonn.

I am indebted to a number of persons, together with their institutions, for various kinds of help, first of all to Dr. C.O. van Regteren Altena (RMNH), who stimulated the work to such a large extent. I would also like to remember here Dr. M. Glibert (IRSN), G. Spaink (GD) and besides Dr. H.-J. Anderson (Geologisch-Paläontologisches Institut der Philipps-Universität, Marburg/Lahn), A.W. Janssen (NHM), and Drs. H. Kollmann (Vienna), C.P. Nuttall (BM), H. Remy (Bonn), and Th.R. Waller (Smithsonian Institution, Washington). Material was also handed to me by several other persons, especially by members of the Nederlandse Malacologische Vereniging and where appropriate their names have been mentioned in the text. Some fine samples were e.g. found in the collection of Mr. H. van Haren. Finally I must mention Mr. J.H. van Os (Leiden), whose fine illustrations form such a valuable contribution to the paper.

SPECIFIC CHARACTERS AND VARIABILITY

The characters used to distinguish the species can be easily understood from fig. 1; this figure (cf. van Urk, 1964) depicts a recent species.

The poorly developed hinge is of little value for identification, though in the length of the horizontal teeth we may find a good additional character. Otherwise in *Ensis* one is almost entirely dependent upon the muscle scars and the shape of the shell. Since these are always more or less variable, one should check as many characters as possible, especially so in a group like this, where seldom more than fragments are available.

Contrary to the usual experience, however, I found the fossil representatives of the genus easier to separate than the Recent ones. Though there are still problems (in Miocene *Ensis* for instance), these may rather be contributed to the comparatively scarce material than to systematic difficulties. The ample material from the Scaldisien and Merxemien could be identified in the majority of cases and if not, it was nearly always because of the fragments being too much damaged. For identification it is necessary to have the anterior part of the shell, since only this presents the specific characters. Therefore other fragments have been excluded from consideration with a few exceptions only. Such exceptions are e.g. the large

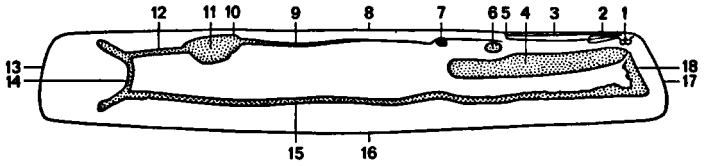


Fig. 1. Diagram of *Ensis minor* (Chenu), left valve. Explanation of figures: 1. Vertical teeth, 2. Horizontal teeth, 3. Ligament groove, under which the nymph, 4. Anterior adductor scar, 5. Posterior end of ligament and nymph, marked by a slight notch in the dorsal shell margin, here called ligament-notch, 6. 'Anterior insertion of retractor pedis anterior muscle' (Graham), here called foot-retractor, 7. Posterior insertion of do., 8. Dorsal shell margin, 9. Dorsal pallial scar, 10. 'Insertion of retractor pedis posterior muscle', 11. Posterior adductor scar, 12. Dorsal pallial scar, 13. Posterior shell margin, 14. Pallial sinus, 15. Ventral pallial scar, 16. Ventral shell margin, 17. Anterior shell margin, 18. Anterior pallial scar.

Fig. 1. Schema van een linkerklep van *Ensis minor* (Chenu). Terminologie: 1. Verticale tanden, 2. Horizontale tanden, 3. Ligament-groeve, waaronder de ligament-plaat, 4. Voorste spierindruksel, 5. Achtereind van ligament en ligament-plaat, gekenmerkt door een kleine inkeping in de dorsale schelprand, de zg. ligament-inkeping, 6. 'Anterior insertion of retractor pedis anterior muscle', hier genoemd voetretractor, 7. Achterste indruk van idem, 8. Dorsale of bovenrand van de schelp, 9. Dorsale of boven-mantellijn, 10. 'Insertion of retractor pedis posterior muscle', 11. Achterste spierindruksel, 12. Dorsale of boven-mantellijn, 13. Achterrand van de schelp, 14. Mantelbocht, 15. Ventrale of onder-mantellijn, 16. Ventrale of onderrand van de schelp, 17. Voorrand van de schelp, 18. Voorste spierindruksel.

posterior ends of *E. complanatus*, the flattened middle parts of the same species and some posterior ends of large *E. degrangei.*

E. arcuatus s.l. is as variable as a fossil species as it is at present and I feel that the possibilities of present nomenclature are hardly satisfactory for such a species with a clinal variation.

In general I found the species readily distinguishable by a combination of characters and though there is variation, overlapping apparently does not occur.

HOW TO USE THE KEY

In this paper a somewhat different type of key is presented. Originally the system has been developed for botanical purposes by Dr. P.W. Leenhouts of the Rijksherbarium, Leiden. The key consists

of a series of numbered couplets and triplets (nos. 1-11), and of a few special characters (nos. 12-15). These numbers give the various characters for distinguishing the species of *Ensis*. Every character is followed by a series of other numbers (1-6) referring to the species, which possess this character. The species, together with their number, are enumerated below.

One example may show how the key works. Suppose we want to identify the species of fig. 7: No. 1 leads to a. Anterior end rounded, which occurs in species nos. 1, 3, 4b, 5 and 6. No. 2 leads to a. Anterior pallial scar sloping backwards, which occurs in species nos. (1), 2 and 3. The species numbers in common, 1 and 3, refer to species which have, or rather which may have the combination of the two characters just mentioned. These are (see below), 1, *E. complanatus* and 3, *E. degrangei*. It will be clear, that proceeding in this way, one may soon get at the correct identification. This has been reached, when only one species number is left. Now key numbers 4-6 may be of little help, but 7 and several other key numbers provide good distinguishing characters for the two species mentioned.

For a more elaborate explanation of this so-called "synoptical key" one is referred to Leenhouts (1966) and Adema (1971).

List of species here discussed

1. *Ensis complanatus* J.D.C. Sowerby, 1844
   (*E. gladiolus* auct., non G.B. Sowerby in Gray, 1839) Pliocene
2. *E. waltoniensis* nom. nov.
   (*E. ensiformis* J.D.C. Sowerby, 1844 nec Conrad, 1843) ..... Pliocene
3. *E. degrangei* Cossmann & Peyrot, 1909 ..... Oligocene-Pliocene
4. *E. arcuatus* (Jeffreys, 1865) ..... Pleistocene-Recent
   4a. *E. arcuatus* s.s. ..... Pleistocene (?)-Recent
   4b. *E. arcuatus* form no. 1 ..... Pleistocene
   4c. *E. arcuatus* form no. 2 ..... Pleistocene
5. *E. ensis* (Linnaeus, 1758) ..... Pleistocene-Recent
6. *E. rollei* Hoernes, 1870 ..... Miocene

KEY TO FOSSIL SPECIES OF ENSIS

A number between brackets means that the character is less frequent, unusual or exceptional in the species mentioned. The numbers in the right-hand columns refer to the species mentioned above.

1. Anterior end								
a. rounded	1	–	3	–	4b	–	5	6
b. truncate	1	2	–	4a	–	4c	–	–
2. Anterior pallial scar								
a. sloping backwards	(1)	2	3	–	–	–	–	–
b. directed forwards	(1)	–	–	4a	4b	4c	5	6
c. perpendicular	1	2	(3)	4a	–	–	–	–
3. Anterior pallial scar								
a. closer to the anterior shell-margin than the ventral pallial scar to the ventral shell-margin	–	2	–	–	–	4c	5	6
b. at the same distance from the a.s.m. as the v.p.s. from the v.s.m.	1	–	(3)	4a	4b	4c	5	6
c. farther from the a.s.m. than the v.p.s. from the v.s.m.	1	–	3	–	–	–	–	–
4. Anterior pallial scar								
a. dorsally and ventrally at about the same distance from the anterior shell-margin	1	–	(3)	–	4b	4c	–	–
b. dorsally closer to the anterior shell-margin	–	2	3	4a	–	–	5	6
c. ventrally closer to the anterior shell-margin	–	–	–	–	–	–	5	–
5. Anterior pallial scar								
a. curved inwards (concave)	–	–	3	4a	(4b)	–	–	–
b. straight	1	2	3	4a	4b	4c	5	6
6. Ventral pallial scar								
a. straight in its anterior part	1	(2)	–	4a	4b?	4c	5	6
b. curved upwards (concave) in do.	–	–	–	4a	4b?	4c	–	–
c. curved downwards (convex) in do.	–	2	3	–	4b	–	–	–
(the curvature in relation to the ventral shell-margin)								

7. Horizontal teeth								
a. shorter than the anterior pallial scar	1	–	–	–	–	–	–	–
b. about as long as do.	–	2	3	4a	4b	4c	–	6
c. longer than do. (up to nearly the shell-breadth)	–	–	3	–	–	–	5	–
8. Horizontal teeth								
a. about $\frac{1}{2}$ of the length of the ligament	–	–	3	–	–	–	–	–
b. about $\frac{1}{3}$ of do.	1	2	–	4a	4b	4c	5	6
c. about $\frac{2}{5}$ of do.	–	2	3	–	–	–	5	6
9. Foot-retractor								
a. before the ligament-notch (the end of the ligament)	1	–	–	–	–	–	–	–
b. opposite to do.	(1)	2	3	–	4b	–	–	–
c. behind do.	–	2	3	4a	–	4c	5	6
10. Anterior adductor scar								
a. as long as the ligament or slightly longer only	1	2?	–	–	–	–	–	–
b. up to about $1\frac{1}{2}$ times the length of the ligament	1	2	3	–	4b	–	–	–
c. decidedly longer	–	–	–	4a	–	4c	5	6
11. Anterior breadth of the shell								
a. more than 15 mm	1	–	–	–	–	–	–	–
b. 10-15 mm	1	2	3	4a	4b	4c	–	–
c. less than 10 mm	1	2	3	4a	4b	4c	5	6

Special characters not occurring in any of the other species:

12. A faint but noticeable ridge parallel to the anterior pallial scar	–	–	3	–	–	–	–	–
13. Anterior pallial scar strongly sloping backwards	–	–	3	–	–	–	–	–
14. Fine grooves on the outer shell surface anteriorly	1	–	–	–	–	–	–	–

15. Anterior adductor scar hardly projecting beyond the ligament 1 2? – – – – – – –

1. *Ensis complanatus* J.D.C. Sowerby, 1844 figs. 2-4

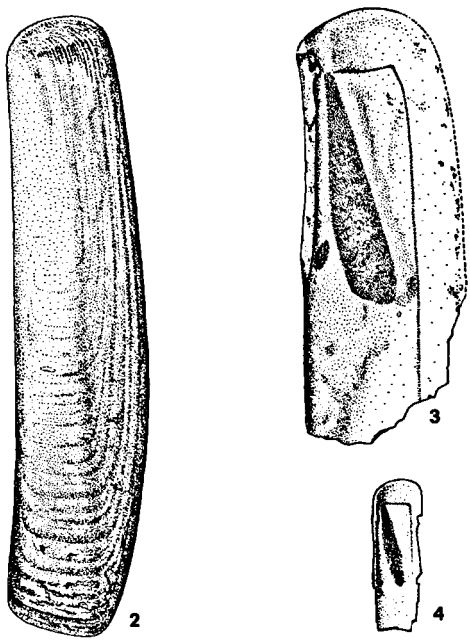
Solen siliqua, Wood, 1840: 245.
Solen ensis var. *a*, Nyst, 1845: 44, pl. 1 fig. b.
Ensis complanatus J.D.C. Sowerby, 1844: pl. 642 figs. 2-4; 1846: 78.
Solen siliqua, Forbes and Hanley, 1853: 249 (*Solen siliqua* of the Red Crag; the "*siliqua*" of the glacial beds may be a form of *E. arcuatus*. See also under 'Variability').
Solen gladiolus Wood, 1857: 254, pl. 25 figs. 8a-c.
Solen siliqua, Wood, 1857: 255, pl. 25 figs. 7a-d (7c?) (the figures of Wood are discussed below under 'Variability').
Solen (= *Ensis*) *siliqua*, Jeffreys, 1865: 20 (*Solen gladiolus* mentioned as a synonym of *Solen* (=*Ensis*) *siliqua*).
Solen siliqua (?) var. *gladiolus*, Nyst, 1878: pl. 25 fig. 9a-c.
Solen siliqua var. *gladiolus*, Nyst, 1881: 232.
non: *Ensis gladiolus* G.B. Sowerby in Gray, 1839: 153, 43, fig. 4.

Shell very large, broad, straight or slightly curved, the hinge-region slightly turned upwards, ventral margin more strongly curved than the dorsal, the shell being broadest in the middle, posterior end of about the same breadth as the anterior end or broader; anterior end rounded or, especially in large specimens, obliquely truncate; on the anterior surface a number of striae, which may partly cross the growth lines – as far as I have seen such striae are not present in any other *Ensis* species; shell flat and compressed, which is a characteristic feature in this species, hence the name *complanatus*, anterior and posterior apertures as a result of this narrow, longitudinally oval, the anterior aperture with its greatest breadth in the middle.

Hinge. – Horizontal teeth about $\frac{1}{3}$ of the length of the ligament, shorter than the anterior pallial scar; hinge terminal to subterminal, this latter especially in young specimens with rounded anterior end.

Muscle scars. – Anterior pallial scar at about the same distance or farther from the anterior margin as the ventral pallial scar from the ventral margin; perpendicular (a), sometimes slightly directed forwards (b) or, in a few specimens, slightly sloping backwards (c); slightly diverging from the anterior margin downwards or parallel to it; at right angles with the ventral pallial scar and the dorsal line of

the anterior adductor scar (a), the angles being obtuse and acute (b), or acute and obtuse (c); both the anterior pallial scar and the ventral pallial scar under the anterior adductor scar straight. Anterior adductor scar very short, not or hardly exceeding the ligament in length, in large specimens not more than about 1 cm projecting beyond the latter, directed downwards or the anterior part about parallel to the hinge and then with a curve directed downwards, its top blunt and straight, the dorsal line in large specimens at some distance from the nymph, a more or less conspicuous widening halfway its length, obliquely truncate posteriorly, where it is about three to four times wider than at the top. Foot-retractor before the ligament-notch or, sometimes, opposite to it, elliptical and comparatively large. Posterior adductor scar nearly bordering the pallial sinus. Pallial sinus short and rounded, its breadth exceeding the length.



Figs. 2-4. *E. complanatus* J.D.C. Sow. 2. Merxemien (IRSN), x 0.85. 3. Antwerp (H. van Haren colln.), x 1.3. 4. Fragment of juvenile shell (IRSN), x 0.85.

Dimensions. – This is one of the largest *Ensis* species, fossil or recent. Nyst (1881) gives the following measurements: "Notre plus grand exemplaire mesure 25 mill. de longueur, sur 142 mill. de largeur, l'épaisseur de la coquille n'atteint que 10 mill. au côté antérieur." These measurements are still exceeded by the statement of Glibert (1959), who writes about "Cette forme de très grande taille, qui atteint 200 mm de long et 35 mm de diamètre umbono-ventral".

Variability. – The species shows little variation. The anterior pallial scar, which is usually perpendicular, may be slightly directed forwards or slightly sloping backwards. This latter feature reminds one of *E. degrangei* and of *E. waltoniensis*, but the other characters usually at once separate *E. complanatus* from these two species.

Wood (1857), in his description of *Solen gladiolus,* mentions a variation of the anterior pallial scar, which I did not find in the material from the Scaldisien. "Much importance", he writes, "has been placed upon differences in proportional dimensions. In this the length is about five times that of its height, while in *S. siliqua* some specimens are as one to eight. The greatest difference appears to be in the impressions of the margin of the mantle; in this it is more inward, or further from the anterior edge, and, on the contrary, the more linear shell (*S. siliqua*) has the impression nearer the extremity with a slight difference also in the form of the anterior adductor." These differences could well serve to distinguish *E. complanatus* from *E. siliqua,* but the latter species apparently does not occur in the Scaldisien.

Wood's figures 8c and 7b (a: same specimen, outer surface) are typical; fig. 7d (c: same specimen, outer surface) shows his second form with the anterior pallial scar distinctly closer to the anterior margin and directed forwards, thus resembling *E. siliqua,* but still with the typical short anterior adductor scar of *E. complanatus*; fig. 8a (b: same specimen, outer surface) is more or less intermediate if not almost typical; fig. 7e may be young *E. complanatus* or perhaps *E. waltoniensis.*

Specific distinction. – *E. complanatus* can be easily recognized by (1) its size ("par les dimensions exceptionnelles" as Dr. Glibert very justly writes to me), (2) the rounded anterior end, especially in small fragments (large specimens may have the anterior end truncate as well), (3) the nearly always perpendicular anterior pallial scar forming a right angle with the ventral pallial scar, (4) the anteriorly straight ventral pallial scar, (5) the very short anterior adductor scar, which hardly projects beyond the ligament, even in young speci-

mens, and (6) the position of the foot-retractor anterior to the end of the ligament, or, only in rather few specimens, opposite to it. The striae on the anterior shell surface seem to be characteristic.

Young specimens are scarce in the material and initially I wondered whether *E. waltoniensis* might be no more than a young stage of *E. complanatus.* Once finding young *E. complanatus,* however, it proved to be quite characteristic, showing all features of the adult but for the dimensions. Differences between young *E. complanatus* and *E. waltoniensis* are given under the latter species.

E. arcuatus var. *norvegica* from Holocene deposits in Norway may superficially resemble *E. complanatus* (abbreviated: *c*), but differs from it in several reliable characters: (1) anterior adductor scar about $1\frac{1}{2}$ times the ligament (*c.*: hardly longer than the ligament), (2) anterior pallial scar slightly closer to the anterior margin than the ventral pallial scar to the ventral margin (*c.*: just the opposite), (3) foot-retractor opposite to or just behind the ligament-notch, that is the end of the ligament (*c.*: usually before or else opposite to), (4) dorsal line of anterior adductor scar nearly parallel to the dorsal shell margin (*c.*: anterior adductor scar directed downwards). Other differences for complete specimens are: posterior adductor scar at a distance of its own length from the pallial sinus, or farther inside (*c.*: nearly bordering the pallial sinus), posterior end slightly narrowed (*c.*: broadened), and shell distinctly more slender than that of *E. complanatus.*

E. complanatus is proportionally broader than any of the species mentioned here, perhaps with the exception of *E. waltoniensis*, but it is hard to give exact figures with mainly hinge-fragments at hand.

Nomenclature. – There seems little cause for confusion since our material so completely agrees with the *E. complanatus* of Sowerby. However, nomenclature sometimes follows its own way, and that is perhaps why the name *E. gladiolus* has turned up in this respect. Though the name is already to be found in Wood (1857), he is probably not the first to use it for the fossil species. But this much is certain, that the name *E. complanatus* has almost completely, if not entirely, disappeared since. Now *E. gladiolus* has originally been described as a Recent species from Chile by G.B. Sowerby and not Gray as generally stated. The correct citation should be: *Ensis gladiolus* G.B. Sowerby, 1839, in J.E. Gray, Molluscous animals and their shells, in: The Zoology of Captain Beechey's Voyage . . . to the Pacific and Behring's Straits, performed in his Majesty's Ship Blossom, etc., p. 153, pl. XLIII fig. 4. The name of the author is mentioned on p. 143 in this work: "The following notes relating to

such shells as are represented in Plates XXXIII to XLIV and not referred to in the foregoing pages, have been put together at the request of CAPTAIN BEECHEY by G.B. SOWERBY, F.L.S."

In South-America *E. gladiolus* is preoccupied by *E. macha* (Molina): *Solen macha* Molina, G.I., 1782, Saggio sulla Storia naturale del Chili, p. 203. I owe this latter information chiefly to Prof.Dr. L.B. Holthuis of the Leiden Museum, who kindly lent me from his library the original description, which otherwise is difficult to obtain. It is hardly necessary to mention that this recent Chilean species is different from the Tertiary *E. complanatus.*

Ensis (Solen) siliqua gladiolus Gray, 1839 has also been used for *E. complanatus* and is already mentioned by Nyst (1878, 1881). Recent *E. siliqua* (L.) of European waters, however, is also a different species.

Stratigraphical distribution. – *E. complanatus* is a species of the Upper Scaldisien[1] and the Merxemien. I have seen only one sample which may be of older origin (IRSN, No. 71, I.G. 21.577, 1 fr., see under 'Material'); its occurrence in such older layers needs confirmation. About 25 samples, however, bear no other information than "Scaldisien" with a locality. Asking Dr. M. Glibert if he could supply any other stratigraphical data about them, he kindly wrote to me: "... d'après mes propres observations sur le terrain et un examen critique des anciennes collections avec l'aide de Monsieur le Prof. de Heinzelin, je crois pouvoir avancer que E. complanatus (= E. siliqua gladiolus dans mon tableau stratigraphique: Bull. I.R.Sc.N.B., t. XXXIV, n°32, p. 9, 1958) n'a été rencontré aux environs d'Anvers, avec certitude, que depuis les Sables d'Austruweel jusqu'au sommet des Sables du Kruisschans, avec une nette abondance dans le sommet même du Scaldisien (Sables à Melampus) (même tableau stratigraphique p. 2). Ces niveaux étaient précisement bien représentés dans la plupart des localités énumérées, surtout à Wyneghem, Polderdyck et Bassin America."

It is hard to say when exactly the species reached its greatest quantitative distribution, but it is the commonest *Ensis* species of the Merxemien (see also under *E. degrangei* 'Stratigraphical distribution'). Since large *Ensis* only occur in comparatively cold waters, it is interesting, that the large *E. complanatus* flourished in the period just before the Pleistocene, quite different from the distribution patterns of *E. degrangei* and *E. ensiformis.* Morphologically its

1 Spelling of these geological names consistently follows that in French and Dutch.

nearest relatives are the large *E. directus* auct. from Atlantic North-America, the equally large *E. arcuatus* (Jeffr.) var. *norvegica* van Urk (Pleistocene to Recent in Norway), and *E. magnus* Schum. (Faeroes, Norway).

The Dutch material has been collected washed ashore on two localities (Ellewoutsdijk and Ritthem, both along the Westerschelde), at Brielle (also originating from the Westerschelde, but from dredgings), and from borings. The locality Brielle needs further explanation. Shells for industrial purposes have been dredged in this country for many years and the material from several places in the Westerschelde has been deposited on the factory grounds at Brielle for its final destination (see e.g. Altena, 1938). Collectors have gladly availed themselves of the opportunity to obtain fossil material here; in fact the large sample from the Westerschelde is almost sure to have been collected partially, if not entirely, at Brielle and the same may hold true for all other material with no further indication than Westerschelde. The material from borings, with a few exceptions, is all from the Merxemien, Dutch records from the Scaldisien being scarce. Whether the statement "Icenien" at the sample from Mill (Escharen) is correct, I am unable to decide. The species has been found here together with *E. degrangei,* but confirmation of its Pleistocene occurrence is necessary.

In Britain *E. complanatus* is one of the "Crag Mollusca".

Material.[2] – NETHERLANDS, washed ashore: Ellewoutsdijk, 7 fr., leg. A.W. Janssen (NHM, No. 1993); do., 3 fr., leg. A. Slabber (NHM, No. 1997); Ritthem, near fort Rammekens, 1 fr., leg. A. Slabber (NHM, No. 1998); dredged samples (see text): Westerschelde, 68 fr. (e.g., 1 hinge-fr. of juv. specimen), leg. J.A.W. Lucas c.s. (Com., No. 1804); do., 4 fr., leg. H. Smits, 1950-1954 (RMNH, No. 1654); Brielle, 10 fr., 10-X-1959 (leg. & coll. H. van Haren); do., 8 fr. (leg. & coll. M.C. Cadée); material from borings in GD: Merxemien: Bergen op Zoom, "gest. Vrederust", 49 B/174 = 640/47, 78.45 m., 4 fr.; Deventer, "gem. waterleiding", 27 G/19 = 375/5, 120.00-128.00 m., 9 fr.; do., 27 G = 394/39, 128.00-133.00 m., 1 fr.; Elst, 40 C/34 = 511/12, 113.80-115.30 m., 5 fr.; Hoogeveen, "waterleiding", 17 C/34 = 239/13, 133.50-134.20 m., 2 fr.; Oss, 45 E/9 = 570/3, 32.50-52.00 m., 12 fr.; Zeeland, St. Hubertusslot, 45 H/6 = 610/3, 22.25-60.00 m., 26 fr. Scaldisien: Reek, 45 F/48 = 571/24, 14.00-31.80 m., 1 fr. Pliocene: Bergen op Zoom, "waterwinplaats", 49 E/30-32 = 622/7-9, 1 fr. (Pliocene with ?); Zeeland, St. Hubertusslot, 45 H/6 = 610/3, 22.25-60.00 m., 40 fr. (see similar sample under Merxemien); Icenien (?): Mill (Escharen), 45 F/2 = 590/2, 11.50-15.00 m., 1 fr. BELGIUM: Numerous fragments and some undamaged (or nearly undamaged) specimens from the Merxemien (25 samples) and the

2 The following abbreviations have been employed here: ex. for example(s) or specimen(s), fr. for fragment(s).

Scaldisien (41 samples) in IRSN. Since a few samples may be of older origin than the Sables d'Austruweel, I will mention them here briefly, leaving otherwise the question to the stratigraphical specialists of the Scaldisien. The nos. 5 (no I.G.-number), I.G. 20.649 (41), I.G. 20.649 (68) and I.G. 18.201 (107) may be from the Sables de Kallo. One number, I.G. 21.577 (21) bears the information "Falun blanc à Pecten gerardi". Van den Bosch (1966) places the layers with *Chlamys (Pecten) gerardi* at the same level as the Sables de Luchtbal, and the Coralline Crag Facies, that is still below the Sables de Kallo. The sample contains only 1 fr. of *E. complanatus*. According to the labels nos. I.G. 20.649 (49) and I.G. 20.649 (53) are from the "Pleistocène supérieure."

Young specimens are represented in I.G. 22.185 (50), 20.644 (60), 8.845 (75), 8.289 (83), 13.130 (84), 10.591 (97), 18.121 (121), 2.738 (124), 18201 (159), 9.149 (215).

2. *Ensis waltoniensis* nom. nov.
figs. 5, 6

Solen ensiformis nomen nudum, Wood, 1840: 245.
Ensis ensiformis J.D.C. Sowerby, 1844: pl. 642 fig. 1; 1846: 77.
Solen ensis, Wood, 1857: 256, pl. 25 figs. 6a-f (6e-f shown on plate as 5c and 5f).
non: *Ensis ensiformis* Conrad, 1843: 326.
non: *Solen ensis*, Locard, 1886: 371 (in footnote "*Melius ensiformis*").

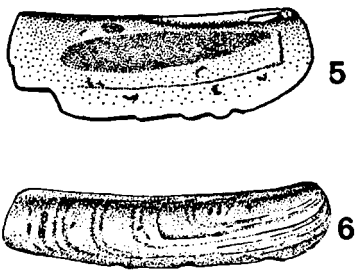
Shell small, broad, slightly curved, ventral margin somewhat more strongly curved than the dorsal, the shell being broadest at about $\frac{2}{3}$ of its length and slightly tapering towards the posterior end, or the margins parallel without tapering towards the posterior end; anterior end obliquely truncate, anterior aperture ovate, with its greatest breadth in the middle.

Hinge. – Horizontal teeth about $\frac{1}{3}$ of the length of the ligament, shorter than the anterior pallial scar; hinge terminal.

Muscle scars. – Anterior pallial scar slightly closer to the anterior margin than the ventral pallial scar to the ventral margin (the respective distances in the largest fragments being about 3 and 4 mm), slightly diverging from the anterior margin, at approximately right angles with the ventral pallial scar and the dorsal line of the anterior adductor scar, often also slightly sloping backwards, the angles then becoming obtuse and acute respectively; anterior pallial scar straight or slightly curved (concave), ventral pallial scar curved (convex) anteriorly, though it may also be straight in some specimens. Anterior adductor scar short, in a measured fragment about $1\frac{1}{2}$ times the length of the ligament, more or less directed downwards, top slightly curved upwards, the first half of its dorsal line parallel to the hinge, close to the nymph, but diverging from it

posteriorly, a conspicuous widening halfway its length, obliquely truncate posteriorly, where it is about three times wider than at the top. Foot-retractor behind or opposite the ligament-notch. Posterior adductor scar and pallial sinus as yet unknown.

Dimensions. – The largest fragment, or rather the largest fragmentary specimen (Antwerp, coll. Cadée, see 'Material') measures 11 mm in breadth anteriorly. This is nearly matched by some fragments in the large sample from Oorderen (IRSN, see 'Material'), which are up to 10 mm broad anteriorly. Two specimens from Walton-on-Naze, England (BM, No. 4492, part of the lot containing the one figured by Wood) measure 45 x 9 and 48 x 9 mm respectively. They seem to be quite or almost undamaged posteriorly and this would mean, that *E. waltoniensis* is one of the broadest, if not the broadest, species of the genus, its length exceeding the breadth five to six times only. The range of variation is about as given by Wood (1857, pl. 25, figs. 6a-d).



Figs. 5-6. *Ensis waltoniensis* nom. nov. 5. Vlissingen (GD), slightly less than $1\frac{1}{2}$ times. 6. Walton-on-Naze, Crag (BM), about natural size.

Variability. – Though *E. waltoniensis* is a uniform species, there is some variation in the length of the anterior adductor scar, which in a few selected specimens ranges from 1.36 to 1.53 times the length of the ligament. In general the largest specimens have the shortest anterior adductor scar in relation to the length of the ligament, a common feature in *Ensis*; perhaps it would be better to say, that these specimens have the largest ligament.

Wood (1857, fig. 6f = 5f on the plate, see note sub synonymy, and 6e = 5c on the plate) depicts two specimens with the anterior adductor scar hardly exceeding the ligament in length, a feature

which I did not observe in my material; besides in fig. 6e (5c on the plate) the ventral pallial scar is quite straight.

Specific distinction. – *E. waltoniensis* can be best recognized by a combination of characters. It is a small species with truncate (upper) anterior end, the anterior pallial scar lies somewhat closer to the anterior margin of the shell than the ventral pallial scar to the ventral margin, the scar is usually slightly diverging from the anterior margin and either perpendicular or, more often, slightly sloping backwards, the ventral pallial scar is more or less curved (convex) anteriorly and the horizontal teeth are short, viz., about $\frac{1}{3}$ of the ligament and shorter than the anterior pallial scar.

Young *E. complanatus* differ from *E. waltoniensis* (abbreviated *w.*) by: (1) its rounded anterior end (*w.*: truncate), (2) the anterior adductor scar being blunt and straight at the top (*w.*: narrow and slightly curved upwards at the top), (3) the anterior pallial scar being perpendicular (*w.*: often slightly sloping backwards), and (4) situated at greater distance from the anterior margin (*w.*: slightly closer to the anterior margin than the ventral pallial scar to the ventral margin), and (5) the straight ventral pallial scar (*w.*: more or less curved (convex)).

Nomenclature. – Sowerby's figure, though only showing the outer surface, gives the characteristic appearance of the species. Mr. C.P. Nuttall writes to me: "We have two specimens bearing this name in the Sowerby collection. One is labelled as being figured in Min. Conch. Vol. 7, pl. 642, p. 77 of 1844 but it is a right valve whilst the figure is of a left valve. The dimensions, however, are correct and Sowerby sometimes used the mirror image when illustrating bivalves, so there is a reasonable chance that we have to do with the figured specimen. All the other shells in our collection from the Crags are labelled *ensis*. S.V. Wood, who first proposed *ensiformis*, eventually placed it in the synonymy of *ensis* (1857, *Mon. palaeontogr. Soc.* p. 258 (= Mon. Crag Moll.)) regarding it as . . . "no more if scarcely so much, as a distinct variety of S. ensis." "

The supposed type specimen, Reg. No. Brit. Mus. (Nat. Hist.) Palaeont. Dept. 44024/1, from Ramsholt, Suffolk, Sowerby collection, purchased from J.D.C. Sowerby, 1860, is 39.5 mm long. On comparing the photograph of this shell with Sowerby's figure (1844), however, I am not quite convinced, that the two represent the same specimen. It is also true, that on the photograph the anterior margin is slightly more rounded and the anterior pallial scar lies farther inside than is usual, which features remind one of (young) *E. complanatus*. The samples from the Crag all contained

the species, which is figured in Sowerby's Mineral Conchology (1844) and which is regarded therefore as *E. ensiformis* J.D.C. Sowerby, in spite of the slight discrepancies on the photograph.

However, as Mr. Nuttall writes to me, Conrad used the name *E. ensiformis* validly in December, 1843, for an American Miocene species. Dr. Th.R. Waller has kindly submitted samples of this species, which proved to differ from European *E. ensiformis* J.D.C. Sow. 1844 (1846); the only European species with which the American shells can be confused is *E. degrangei.* For this reason *E. ensiformis* J.D.C. Sow. is in need of a new name and I here propose *E. waltoniensis* as suitable for two reasons: (1) the Waltonien being one of the layers of the Crag in which it regularly occurs, and (2) Walton-on-Naze is a well-known locality for the species.

Stratigraphical distribution. – *E. waltoniensis* first appears in the lower Scaldisien and seems to be fairly evenly distributed from the Sables de Kallo upwards into the Merxemien. It may be somewhat scarcer though in the older layers of the Scaldisien and its occurrence in the Sables de Kattendijk needs confirmation, since I have seen only one fragment from these layers (IRSN, I.G. 16.618/161). Otherwise there is no indication, that it is commoner in one period than another, nor that there is an increase or decline towards the Pleistocene.

The species makes up about ten percent of the total number of *Ensis* fragments in the Belgian material from the Scaldisien/ Merxemien (see also *E. degrangei*, 'Stratigraphical distribution'). Usually the samples contain a small number of fragments with one exception of 110 identified fragments (see 'Material'), which is only slightly less than half the total number (about 250) examined of *E. waltoniensis.*

The two Dutch samples are from borings; the species has never been found washed ashore, nor is it known from the Westerschelde or Brielle. In England it belongs to the "Crag Mollusca".

Material. – NETHERLANDS: Roosendaal, 3 fr., Middle-Pliocene (GD, 49F/73 = 642/9); Vlissingen. 11 fr., without stratigraphical data, but considering other material mentioned here, no doubt from the Scaldisien or Merxemien (GD, 48D/46-54 = 656/67-73). BELGIUM: About 40 samples with about 250 fragments, of which attention is drawn to the following: Oorderen near Antwerp, 1 fr., Sables de Kattendijk (?), perhaps the only fragment from these layers, see 'Stratigraphical distribution' (IRSN, I.G. 16.618/161; do., 110 fr., Sables de Kallo, layers with *Neptunea contraria,* horizon with *Pinna* (IRSN, I.G. 18.201/210); Antwerp, dock 7, Sables de Kruisschans and Austruweel, 4 fr., among which the largest known specimen (mentioned under 'Dimensions'). Besides, the following samples, and perhaps a few more, contain *E.*

waltoniensis: 8, 14, 15, 19, 26, 31, 33, 40, 41, 43, 47, 49, 50, 52, 55, 57, 58, 60, 71, 73, 106, 111, 118, 124, 127, 149, 151, 158, 159, 161, 169, 172, 206, 208, 210, 215, 216, 220, 222, 225, 226. GREAT BRITAIN: Essex, Walton-on-Naze, 63 fr., Red Crag, leg. L. v.d. Slik (NHM, No. 5279); do., 2/2, slightly damaged, Waltonien (GD, 21/19); do., 4 fr. and ex., 2 of them practically undamaged. Part of the lot containing the one figured in Wood (1857, pl. 25 fig. 6c; Mr. C.P. Nuttall, in litt.), BM No. 4492; do., 8 fr. and damaged specimens, leg S. Wood. Original label "S. Wood Coll. 1842. Trans. Zool. Dept. 1896, Crag, Suffolk, L. 14309 S. Wood Esqr." (BM); do., 14 fr. and ex., at least one almost undamaged, Coralline Crag (BM).

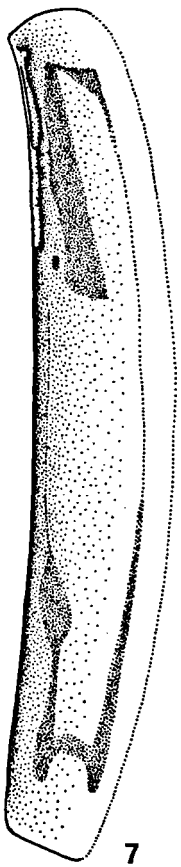
3. *Ensis degrangei* Cossmann & Peyrot, 1909
figs. 7-9

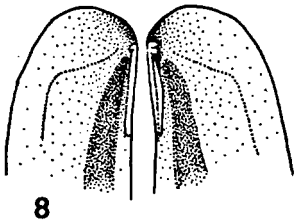
? *Ensis hausmanni*, Goldfuss, 1841: 277.
Ensis Degrangei Cossmann & Peyrot, 1909: 153, pl. 4 fig. 19 (+ fig. 18, same fr.), fig. 10; ? also figs. 6, 7, 9, 11.
Solen siliqua L. var. *minor* (= *S. ensis*, see Nyst, 1881: 232, footnote); Nyst, 1878: pl. 25 fig. 9e.
Solen ensis, Nyst, 1881: 232.
Ensis spec., Janssen, 1966: 112 ("voorste mantellijn divergerend").
?*Ensis* spec., Anderson, 1964: 182.

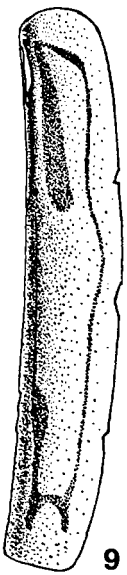
Shell small to moderately sized, broad, slightly to moderately curved sometimes straight, ventral margin more strongly curved than the dorsal, the shell being broadest in the middle, tapering towards the posterior end; anterior end rounded, posterior end obliquely truncate.

Hinge. – Horizontal teeth up to $\frac{1}{2}$ of the length of the ligament, as long as the anterior pallial scar or longer; hinge subterminal.

Muscle scars. – Anterior pallial scar farther from the anterior margin than the ventral pallial scar from the ventral margin, sloping backwards, often strongly so, and thus diverging from the anterior margin, forming an obtuse angle with the ventral pallial scar and an acute angle with the dorsal line of the anterior adductor scar, sometimes perpendicular and at right angles ventrally and dorsally; anterior pallial scar often more or less curved inwards (concave), sometimes to such a degree, especially so in young specimens, that it forms a right angle with the ventral pallial scar; ventral pallial scar curved outwards (convex) anteriorly. In the majority of the specimens a faint but well-observable rib, parallel to the anterior pallial scar, is present, a feature which I have not seen in any other *Ensis* species up till now. Anterior adductor scar short, not more than about $1\frac{1}{2}$ times the length of the ligament, diverging from the dorsal shell margin towards the posterior end, top straight or slightly







Figs. 7-9. *Ensis degrangei* Cossm. & Peyr. 7. (IRSN), x 1.4. 8. Interior to illustrate the backward sloping anterior pallial scars. 9. (IRSN, No. 115), x 0.9.

curved upwards, a more or less conspicuous widening in the middle, obliquely truncate or somewhat rounded posteriorly, where it is about three times wider than at the top. Foot-retractor opposite the ligament-notch or just behind it. Pallial sinus short, about equally long as broad.

Dimensions. – Though *E. degrangei* is figured by Cossmann & Peyrot as a small species of not more than 5-7 mm breadth, it may

reach considerably larger dimensions. A large specimen from Antwerp (Kallo), leg. A.W. Janssen (NHM), is 84 mm long and 14 mm broad (greatest breadth in the middle of the shell), breadth anteriorly 11 mm, posteriorly 8 mm. This is by no means the maximum, since the anterior breadth of 11 mm is still exceeded by that of several hinge-fragments, e.g., Westerschelde, leg. J.A.W. Lucas c.s. (Com., No. 1804), 1 fr. of 15 mm breadth anteriorly. Such dimensions, however, are only reached by Pliocene specimens, while material from the Oligocene and Miocene is usually not much larger than the Miocene fragments illustrated by Cossmann & Peyrot.

Variability. – Variation in *E. degrangei* is less than one perhaps would expect from so common a species and is mainly confined to the anterior pallial scar, which may be more or less strongly divergent. In a few specimens it is perpendicular and at right angles with the ventral pallial scar and the dorsal line of the anterior adductor scar. Such shells may be mistaken for *E. arcuatus*, but can be recognized by other characters (see *E. arcuatus* form no. 1); the long ligament may be especially helpful here. Examples of such shells are mentioned under 'Material'. Otherwise the degree of concavity of the anterior pallial scar is variable. It may be straight or nearly so, slightly concave or concave to such a degree, that there is a deep curve in the middle, the scar forming a right angle with the ventral pallial scar, but an acute angle with the dorsal line of the anterior adductor scar.

Straight shells now and then occur, but are not likely to present difficulties in identification.

Specific distinction. – *E. degrangei* can usually at once be recognized by its strongly diverging anterior pallial scar, a feature which I have never seen in any other *Ensis* species, fossil or recent, except *E. waltoniensis* and a few *E. complanatus*, where it is present to a much lesser degree, if at all. Other useful characters are: (1) the rounded anterior end, placing the hinge in a more or less subterminal position, (2) the distance between the anterior pallial scar and the anterior margin which is greater than that between the ventral pallial scar and the ventral margin, (3) the curved, convex, ventral pallial scar below the anterior adductor scar, (4) the usually more or less concave anterior pallial scar, and (5) the long horizontal teeth occupying about half the length of the ligament. The rib along the anterior pallial scar, though inconspicuous, is typical for the species and very useful as an additional character.

E. degrangei differs from *E. rollei* especially by the divergent

anterior pallial scar, the rib, and the long horizontal teeth; moreover, it reaches much larger dimensions.

Specimens with a perpendicular anterior pallial scar may resemble *E. arcuatus* but differ from it mainly by the long horizontal teeth and the rib; see also *E. arcuatus* form no. 1.

Nomenclature. – The paragraph by Cossmann & Peyrot (1909: 153): "La branche antérieure oblique sous le crochet et séparée de la région buccale par un épaississement obsolète" mentions two characteristic features and leaves no doubt about the identity of *E. degrangei.* Both characters are also clearly illustrated in their fig. 19. About the other figures I am less certain. Some of these seem to have a perpendicular anterior pallial scar, which may occur in *E. degrangei,* but also reminds one of *E. rollei.* Fig. 18 of Cossmann & Peyrot shows the same fragment as fig. 19, but from the outside. The fragment of fig. 19 had been obtained at Saucats (Lagus), Aquitanien supérieur.

Whether *Ensis hausmanni* is a synonym I am not able to decide at the moment. Though the name is sometimes ascribed to Schlotheim (1820), the species is not mentioned in this work, which may be the reason that never a page is given! Sherborn (1927: 2924) quotes the species as *Solen hausmanni* v. Schlotheim, in G.A. Goldfuss, Petr. German. II (7), 1840, 277, which according to Dr. H.-J. Anderson should be *Ensis hausmanni* Goldfuss, 1841, Petref. Germ. 2: 277. He writes to me: "Die Art ist, soweit dem Text zu entnehmen ist, auf Steinkernen begründet. Als locus typicus ist angegeben der Grafenberg bei Düsseldorf und Güntersen bei Dransfeld in Südhannover. Beide Fundorte sind unzweifelhaft Oberoligocän". It is impossible to draw any systematical conclusions from the brief description in Goldfuss and the same holds true for two of his three figures. The third figure shows the inside with a perpendicular anterior pallial scar. Now this may occur in *E. degrangei,* but is certainly not characteristic for the species. Dr. H. Remy kindly sent me "4 Stücke von Solen hausmanni ---, die bei uns in der Sammlung als fragliche Goldfuss Originale registriert sind". One of these shows the interior of the shell with a slightly diverging anterior pallial scar and could be *E. degrangei*, but also *E. waltoniensis* or even another species. The identity of *Solen (Ensis) hausmanni* thus being doubtful, it seems advisable to use for our species the name *E. degrangei* as interpreted above.

Stratigraphical distribution. – *E. degrangei* is geologically the oldest of the species mentioned here, occurring from at least the

Upper Oligocene throughout the Miocene to the Pliocene/ Merxemien.

It is by far the commonest *Ensis* species in the Scaldisien. Counts from the material in the Brussels museum gave the following results: *E. complanatus*-310, *E. degrangei*-1526, *E. waltoniensis*-242 (altogether 2078 fragments and specimens). These figures and a small number of other samples represent all material that could be identified, roughly 80-90%. This means, that of the *Ensis* species in the Scaldisien/Merxemien about 75% belongs to *E. degrangei*, about 15% to *E. complanatus* and about 10% to *E. waltoniensis*. Considering that one of the *E. waltoniensis* samples contains 110 identifiable hinge-fragments, nearly half the total number of 242, while the second largest sample consists of only 11 fragments, 10% for this species may be even somewhat too high.

A comparison of the number of samples from the various layers gives the following results:

	number of samples				percentage		
Pliocene	*E. compl.*	*degr.*	*walt.*		*E. compl.*	*degr.*	*walt.*
Merxemien	25	12	7		55%	26%	18%
Scaldisien							
total	41	130	31		20%	65%	15%
layer unknown	32	51	11				
Sables d'Austruweel	3	3	2				
Sables de Kallo	?5	16	6				
Sables de Luchtbal	?1 (1 fr.)	15	3				
Sables de Kattendijk	—	28	1	(1 fr.)			

17 6

One or two notes must be made at these figures. The samples with no other indication than "Scaldisien" have been shown as "layer unknown'. Two figures, 17 and 6, for *E. degrangei* and *E. waltoniensis* have been shown separately, because I am not sure whether to place them in the Sables d'Austruweel or the Sables de Kallo. The labels bear the information: layers with *Neptunea contraria* (= *Chrysodomus contrarius*).

Apart from this the figures give rise to some interesting conclusions as to the stratigraphical distribution of the species. *E. degrangei*, by far the commonest species, is distributed throughout the Scaldisien, but apparently on the decline in the Merxemien. *E. complanatus*, the second commonest species and five times out-

numbered by *E. degrangei*, is by far the commonest species in the Merxemien, even commoner than *E. degrangei* and *E. waltoniensis* together. *E. waltoniensis* begins to appear in the older layers of the Scaldisien, where it is still rare, but otherwise fairly evenly distributed from the Sables de Kallo to the Merxemien.

The stratigraphical position of the Merxemien has often been discussed, the question arising, whether it should be considered as belonging to the Pliocene or the Pleistocene. I do not pretend to give any solution here, but the genus *Ensis* shows, that there is a continuous distribution of the three Tertiairy species from the Scaldisien to the Merxemien. Then there is a break; the Tertiary species disappear and *E. arcuatus* begins its successful distribution in the Pleistocene. The records of one mixed sample of *E. complanatus* and *E. degrangei* from the Icenien and two samples of *E. arcuatus* from the Merxemien (both GD) hardly affect this distribution pattern.

The Dutch material has mainly been gathered from borings and dredgings; probably two fragments only have been found washed ashore. The localities "Westerschelde" and "Brielle" have been discussed under the stratigraphical distribution of *E. complanatus.* If my assumption that all such material originates from shell-dredgings in the Westerschelde is right, the two fragments from Ellewoutsdijk and Domburg are indeed the only ones which have been found on the beach. Otherwise the species has regularly been sampled from borings, both in the Miocene and Pliocene, the Merxemien included. The statement Icenien at the sample from Mill (Escharen), where it has been found together with *E. complanatus,* seems doubtful; confirmation of the Pleistocene occurrence is needed.

Material. – Upper-Oligocene. GERMANY: Meers, Niederrhein, Schacht Kapellen, Eochattien, many fr., Geol.-Paläont. Inst. Philipps-Univ., Marburg/Lahn.

Miocene. NETHERLANDS: material from borings (GD), if not otherwise indicated: Asten I, 52 C, 550.00-560.00 m., 1 fr., Upper-Miocene; Beeringen, Db. 15, 58B/8 = 711/2, 65.00-74.00 m., 1 fr., Middle-Miocene, Hemmoor-Stufe; also fr. in do., Db. 18, 58B/1 = 711/3, 219 m., Middle Miocene, Hemmoor-Stufe; Belfeld, 58E/91, "brandput 44", 35.00-40.00 m., 1 fr., Upper-Miocene; Delden, see Janssen (1966); Helenaveen, Db. 5A, 58 D/28 = 694/5, 335.00-351.00 m., 1 fr., Middle-Miocene, Hemmoor-Stufe; Maasbree, 58 B/4 = 711/6, 3 samples with 13 fr., 3 fr., and 38 fr., without further data, also fr. in do., Db. 13, 141.00 m. and do. Db. 13, 102.00-160.00 m., 10 fr., all Middle-Miocene, Hemmoor-Stufe (the last 10 fr. leg. GD, No. 5188, in NHM); Db. 20, "Uitwateringskanaal", 58 B/35 = 727/1, 70.40-75.40 m., 1 fr. do., 95.40-100.40 m., 1 fr. BELGIUM: Diestien, IRSN, the following 8 samples, all from Antwerp or vicinity; I.G. 20.664 (44), 25 fr.; I.G. 9.122 (46) 1 fr., I.G. 8.751 (123) 12 fr.; I.G. 8.816 (168) 4 fr.; I.G. 9.212 (175) 1 fr., I.G.

9.747 (193) 9 fr.; I.G. 9.095 (196) 8 fr.; I.G. 10.591 (198) 2 fr. FRANCE: see Cossmann & Peyrot (1909): Saucats (Lagus), Aquitanien supérieur. GERMANY: Dingden, Königsmühle, 2 fr., Reinbekstufe, Feinsand, leg. A.W. Janssen (NHM); see also Janssen (1966).

Pliocene. NETHERLANDS, washed ashore: Ellewoutsdijk, 1 fr., leg. A. Slabber (NHM); Domburg, 1 fr., 4-X-1969 (leg. & coll. H. van Haren); dredged, see text: Westerschelde, 16 fr., among which the largest fr. of this species, see text under 'Dimensions', leg. J.A.W. Lucas c.s. (Com. No. 1804); do., 1 fr., 1950-1954, leg. H. Smits (RMHN, no. 1654): Brielle, 2 fr. (leg. & coll. M.C. Cadée); material from borings in the collection of the Geologische Dienst (GD): Scaldisien: Beuningen, 40 C/235, 88.00-94.00 m., 8 fr., Sables de Kattendijk; Deventer, 27 G/35, 148.00-150.00 m., 1 fr.; do., 27G/35, 150.00-152.00 m., 2 fr.; Reek, 45F/48 = 57/124, 14.00-31.80 m., 7 fr. Scaldisien/Merxemien. Deventer, 27 G/35 140.00-150.00 m., 10 fr.; Vlissingen, Mij. de Schelde, 48 D/46-53 = 656/67-73, 2 fr. Merxemien. Zeeland, St. Hubertusslot, 45 H/6 = 610/3, 22.25-60.00 m., 2 fr.; do., 3 fr. BELGIUM: numerous samples containing well over 1500 fr. and specimens from the Scaldisien/Merxemien in IRSN, see 'Stratigraphical distribution'. Examples of shells with perpendicular anterior pallial scar are found in the following samples: I.G. 21578 (30), 18201 (40), 20644 (44), 18201 (52), 12613 (73), 21940 (83), 9963 (89), 9212 (175), 16618 (166), 16416 (176). Straight specimens in: I.G. 21940 (83), 9963 (89). These latter are probably more frequent, but it is impossible to judge whether a shell is straight or not on the strength of fragments only.

?Pleistocene, ?Icenien. NETHERLANDS: Mill (Escharen), 45 F/2 = 590/2, 11.50-15.00 m., 3 fr. (GD).

4. *Ensis arcuatus* (Jeffreys, 1865)
figs. 10-12

Solen siliqua L. var. *arcuata* Jeffreys, 1865: 19.

Ensis arcuatus, van Urk, 1964: 29, pl. 4 fig. 12 (synonymy and fig. of type).

Ensis arcuatus is a common species in Dutch Quaternary layers, where it occurs in at least two different forms, both of them also different from Recent material; moreover, a few fragments are almost, if not entirely, identical with Recent, typical *E. arcuatus*. Though hinge-fragments are readily identified, the forms can hardly be classified in a satisfactory way. This is partly due to the fact, that the anterior adductor scar – an important feature when subdividing the material – is seldom completely available in the fragments. Besides, there is some variation and intermediate forms may occur. In the following lines descriptions are given for *E. arcuatus* s.s. and the two fossil forms; after that the material is enumerated in toto and the distribution is discussed.

a. *Ensis arcuatus* s.s.

Shell large, rather broad, usually slightly curved, margins parallel, anterior and posterior ends of about the same breadth, anterior end obliquely truncate, posterior end truncate.

Hinge. – Horizontal teeth about $\frac{1}{3}$ of the length of the ligament, of about the same length as the anterior pallial scar; hinge terminal.

Muscle scars. – Anterior pallial scar at about the same distance from the anterior margin as the ventral pallial scar from the ventral margin, parallel to the anterior margin or diverging from it downwards, at almost right angles with the ventral pallial scar and the dorsal line of the anterior adductor scar; both the anterior pallial scar and the ventral pallial scar under the anterior adductor scar straight or curved inwards (concave). Anterior adductor rather long, about $1\frac{1}{2}$ to $1\frac{2}{3}$ times the length of the ligament, its dorsal line almost parallel to the dorsal margin of the shell, only slightly diverging from it posteriorly, top curved upwards, widened in the middle, obliquely truncate posteriorly, where it is ca. three times wider than at the top. Foot-retractor behind the ligament-notch. Posterior adductor scar at a distance of about its own length from the pallial sinus. Pallial sinus variable, usually short and truncate.

Dimensions. – Up to about 150 mm long and 20 mm broad.

b. *Ensis arcuatus* form no. 1
fig. 10

The only complete specimen available differs from *E. arcuatus* s.s. in the following characters: (1) anterior adductor scar very short, less than $1\frac{1}{2}$ times the length of the ligament, (2) anterior end rounded, (3) foot-retractor opposite the ligament-notch, (4) ventral margin more strongly curved than dorsal margin, shell broadened at about two thirds of its length, (5) shell more strongly curved.

Dimensions. – Length 105 mm, breadth 16.5 mm (maximum breadth near posterior adductor scar), breadth anteriorly 13.5 mm (here slightly damaged), in the middle 15 mm, posteriorly 13 mm.

Discussion. – The short anterior adductor scar is a characteristic feature in this form. The scar is proportionally somewhat longer in the second specimen, a smaller one from the same sample, but this is a usual feature in *Ensis*. Also in this specimen the length cannot match that of comparable *E. arcuatus* s.s.

		length of shell	length of ligament	length ant.add. scar	a.a.s. /lig.
1. *E.a.* form no. 1	Domburg, fossil	10.5	2.7	3.7	1.37
2. *E.a.* s.s.	Katwijk-Noordwijk, Recent, juvenile	10.5	1.7	3.3	<2
3. *E.a.* form no. 1	Domburg, fossil, younger specimen, posterior end broken off	?	2.3	3.3	1.43
4. *E.a.* s.s.	Katwijk-Noordwijk, Recent, juvenile	9.7	1.7	3.3	<2
5. *E.a.* var. *norvegica*	Riesabugten, Trondheimfjord, Storfosen, Ørlandet, 6 m a.s.l., fossil	<13	±2.5	± 4	1.6
6. *E.a.* var. *norvegica*		<16	3.25	5	1.53

Measurements are in cm. The final column gives the ratio of the length of the anterior adductor scar to that of the ligament.

In specimens of the same length (nos. 1 and 2), the anterior adductor scar in *E. arcuatus* s.s. is nearly twice as long as the ligament, whereas in *E. arcuatus* form no. 1 it is less than $1\frac{1}{2}$ times that length. This also holds true for nos. 3 and 4, in which the anterior adductor scar is of the same length. The length of the ligament in relation to the length of the shell is much greater in *E. arcuatus* form no. 1 than in *E. arcuatus* s.s., viz., 2.7 and 1.7 cm in nos. 1 and 2 respectively; this may well account, at least partly, for the short anterior adductor scar in *E. arcuatus* form no. 1 in relation to the ligament.

As to the other characters, the broadening of the shell at about two thirds of its length reminds one of *E. magnus* Schum., the curvature and rounded anterior end of *E. arcuatus* var. *ensoides* van Urk, the still shorter anterior adductor scar of *E. arcuatus* var. *norvegica* van Urk!

It may resemble large specimens of *E. degrangei* which have the anterior pallial scar perpendicular (though in the Domburg specimens this scar is directed forwards), but *E. degrangei* has long horizontal teeth (up to half as long as the ligament and longer than the anterior pallial scar), while the rib along the anterior pallial scar, though not conspicuous, is of further use. Moreover, the anterior pallial scar in *E. degrangei* is situated at a greater distance from the anterior margin of the shell.

Though there may be some likeliness to fragments of *E. complanatus*, several features mark the difference between the two species. Especially the characters nos. 1, 5, and 6 as mentioned under *E. complanatus* sub specific distinction are helpful; besides, in *E. complanatus* the horizontal teeth are decidedly shorter than the anterior pallial scar, while the anterior adductor scar is blunt and straight at the top.

c. *Ensis arcuatus* form no. 2
figs. 11-12

Shell rather large, broad (anterior breadth up to at least 17 mm), slightly curved or straight with the hinge-part slightly curved upwards, margins parallel, anterior end obliquely truncate.

Hinge. – Horizontal teeth about $\frac{2}{5}$ of the length of the ligament, longer than the anterior pallial scar; hinge terminal.

Muscle scars. – Anterior pallial scar slightly closer to the anterior margin than the ventral pallial scar to the ventral margin (in the fragment illustrated 3 : 3.5 mm, in a second fragment from the same sample, however, 4.5 : 3.5-4 mm, that is somewhat further from the anterior margin), parallel to the anterior margin, directed forwards or perpendicular; anterior pallial scar straight, ventral pallial scar under the anterior adductor scar often slightly curved inwards (concave), otherwise straight. Anterior adductor scar long, about $1\frac{2}{3}$ times the length of the ligament. Foot-retractor behind the ligament-notch.

Fragments of young shells are rather different from any other *Ensis*, only reminding one somewhat of *E. minor* (Chenu): shell straight, hinge-region slightly turned upwards, rather slender; horizontal teeth rather long, slightly less than half as long as the ligament; anterior adductor scar (very) long, up to twice the length of the ligament or even somewhat more, slender, parallel or nearly parallel to the dorsal shell margin, the top narrow and slightly curved upwards, otherwise of about uniform width throughout.

Dimensions. – The largest fragment measures up to 17 mm breadth anteriorly, which is about the normal breadth of full-grown typical *E. arcuatus*.

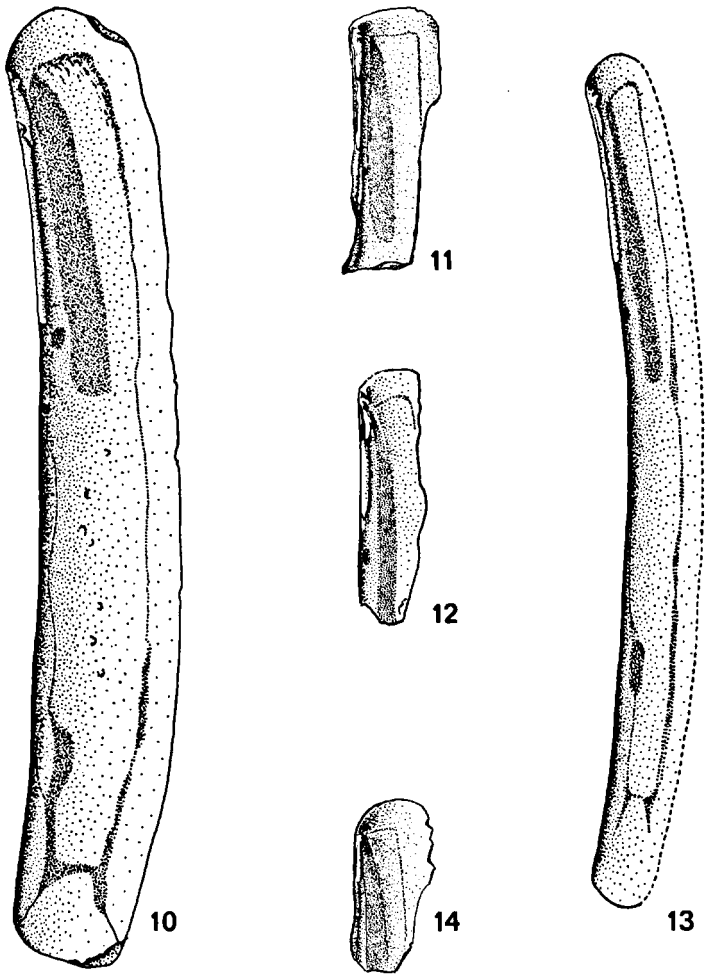
Stratigraphical distribution. – *E. arcuatus* is regularly washed ashore in the Netherlands. Specimens are often yellowish brown with a dark blueish colour in parts of the shell and do not seem to be

quite fresh; on the other hand they seldom have the worn appearance of real fossil material and the valves are frequently still attached to each other. Though variable too, I have never found in such material any of the two forms described here. Since the second form seems to be common in the Eemien and because such fossils are rarely washed ashore at localities where *E. arcuatus* is common, one may reasonably assume that these *E. arcuatus* are not older than Holocene. The specimens, which have been washed up and dredged in Zeeland (Domburg, Domburg-Westkapelle, Westerschelde) may be of older age, perhaps Eemien-Icenien.

The material from borings is derived from Eemien and Icenien, both part of the Pleistocene. Though there are two records from the Merxemien (GD), Pliocene occurrence needs to be confirmed. In the Brussels collections from the Belgian Scaldisien/Merxemien *E. arcuatus* is not present, though there are a few fragments, which might belong to this species.

In general the first form seems to be that of the Icenien and the second one that of the Eemien. In Norway the var. *norvegica* is known from Pleistocene deposits near Trondheim and also Recent from that area.

Material. – NETHERLANDS, washed ashore: Domburg-Westkapelle, leg. A. Slabber (NHM); 1 right valve, practically undamaged, 1 left valve, smaller, damaged, but with the anterior adductor scar complete, both specimens discussed above; Domburg, 4 fr. (1 of form no. 1, the other 3 of form no. 2), 4-X-1969 (leg. & coll. H. van Haren); dredged: Westerschelde, 9 fr. (8 with rounded anterior end as in form no. 1, with truncate anterior end as in form no. 2, none of them with complete anterior adductor scar), leg. J.A.W. Lucas c.s. (Com. no. 1804); material from borings in coll. GD: Merxemien: Diepenveen, 27G/19 = 375/5, 127.00-131.00 m., 1 fr., Dorst, 45D/- = 624/106, 115.30-119.30 m. and 159.05-166.50 m., 2 fr., Icenien: Baanhoek, 38D/106 = 547/123, 2 fr.; Barendrecht, 37H/55 = 524/1, 108.00-110.00 m., 8 fr.; do., 137.99-139.00 m., 9 fr.; Biesbosch 8, 44B/10 = 594/79, 4 fr.; Breda, 50 B/-, 101.00-102.00 m., 2 fr.; Dinteloord, Stampersgat, 43G/14 = 681/10, 45.00-50.00 m., 2 fr.; Dordrecht 15, 44B/3 = 546/266, 118.70-119.20 m., 2 fr.; do., 16, 44B/3 = 546/266, 90.00-123.00 m. , 10 fr.; Dubbeldam, 44B/-, 104.80-130.90 m., 7 fr.; do., Stadswijk, 44A/100 = 546/241, 113.25-117.00 m., 2 fr.; Etten. 50A/15 = 623/6, 77.00-81.00 m., 1 fr.; 's-Gravendeel, 44A/145 = 546/78, 11.25-112.50 m., 3 fr.; Hardenbroek 44B/61 = 547/124, 2 fr.; Hekelingen, 37G/154 = 523/63, 1 fr.; Maassluis, 37B/25 = 500/7, 102.00-109.00 m., 14 fr.; Oosterhout, 44D = 604, 46.00-55.00 m., 1 fr.; do., 44D = 604/201, 78.30-81.30 & 135.50-138.75 m., 3 fr.; do., 44D/29 = 604/190, 7 fr.; Rotterdam, 37E/128 = 501/77, 126.00-128.00 m., 3 fr.; Schouwen, "fauna 3", 42B = 576/3-7, 13 fr.; Sommelsdijk, 43A/8 = 560/1, 66.40-66.55 m., 37 and 39 fr., do., 67.80-68.40 m., 27 fr.; Wassenaar, 30G/36 = 421/16, 135.54-146.00 m., 4 fr. Eemien (all GD): Bergen, N-H., 19A, 3 fr.; Oudendijk, 25D, 31.50-32.70 m., 5 fr.,; Slotermeer 1954, 25D, 20 fr.; Velsen



Figs. 10-14. Fossil *Ensis*. 10. *E. arcuatus* (Jeffr.) form no. 1, Domburg-Westkapelle, washed ashore (NHM, leg. A. Slabber), x 1.3. 11. Do., form no. 2, Slotermeer, Eemien, 1954 (GD), x 0.85. 12. Do., form no. 2, fragment of juvenile shell, Eemien (GD), x 1.3. 13. *E. ensis* (L.), (sub)fossil, beach Scheveningen (R.M. van Urk colln.), x 1.3. 14. *E.* cf. *rollei* Hoernes, Miocene, Vienna Basin (Mus. Vienna), x 1.7.

1936, 25A, 1 fr.; Vogelenzang, 25C, 3 fr.; besides: Halfweg, 3 fr. (GD) Sloterdijk, 1 fr. (coll. E. de Vogel).

5. *Ensis ensis* (Linnaeus, 1758)
fig. 13

Ensis ensis, Van Urk, 1964: 38 (bottom), pl. 1 fig. 4; Van Urk, 1964a: 65, pl. 1 fig. 4; Entrop, 1965: 142 (material mentioned as: "Fossiel?"), fig. 93.

The form described here is mentioned in the above literature. The figure in Entrop (1965) is quite characteristic and from (sub)fossil material. The other figures mentioned here show a similar form; they represent the same, recent specimen.

Shell small, slender to very slender, moderately to strongly curved, margins parallel, tapering slightly, if at all, towards the posterior end, which is at most about 1-2 mm narrower than the anterior end; anterior end rounded, posterior end obliquely truncate or slightly rounded.

Hinge. – Horizontal teeth from slightly more than $\frac{1}{3}$ up to about $\frac{2}{5}$ of the ligament, measuring up from the length of the anterior pallial scar to about the anterior breadth of the shell; hinge subterminal to terminal.

Muscle scars. – Anterior pallial scar at the same distance from the anterior margin as the ventral pallial scar from the ventral margin or, sometimes, slightly closer to the anterior margin, directed forwards, forming an acute angle with the ventral pallial scar and an obtuse angle with the dorsal line of the anterior adductor scar, both the anterior pallial scar and the ventral pallial scar below the anterior adductor scar straight. Anterior adductor scar long, up to about $1\frac{3}{4}$ times the length of the ligament, slender, parallel to the dorsal margin of the shell, only slightly diverging from it posteriorly, its top straight and narrow (about 1 mm wide at most), usually a slight widening just behind or in the middle, rounded or somewhat truncate posteriorly, where it is about three times wider than at the top. Foot-retractor at some distance behind the ligament-notch. Posterior adductor scar at a distance of about $1\frac{1}{2}$ times its own length from the pallial sinus. Pallial sinus rather short, its length usually not much exceeding its breadth, truncate, but sometimes of irregular shape.

Dimensions. – The largest specimens measure up to 100-110 x 10-12 mm. It is decidedly the most slender *Ensis* species, on the average being 8 to 9 times as long as broad.

Variability of *E. ensis* and nomenclature: see Van Urk, 1964.

Distribution. – Though *E. ensis* is a common species in the North Sea extending southward throughout the Mediterranean, the form described here is known only from the Dutch coast, where odd discoloured valves are commonly washed ashore. Its origin is doubtful, since it is not known to occur in Recent state (at least, fresh valves have never been recorded), nor is it found, e.g., in the fossil Quaternary material of the Geologische Dienst (GD). The only two specimens known (two fragments) are from the Eemien; these seem to represent the form which is washed ashore.

The beach material is usually perfectly preserved, but always brown, yellowish brown or sometimes blackish blue in colour. Its condition is about the same as that of the numerous (sub)fossil valves of *Spisula elliptica* (Brown) washed up along our coast and which are probably younger than Pliocene. Summarizing we can say that *E. ensis* probably originated during the Quaternary and that its extension, at least in western Europe, dates from that period.

Specific distinction. – *E. ensis* may especially be recognized by its very slender, curved shell, its parallel margins tapering only to a slight degree posteriorly if at all, the rounded anterior end and the anterior pallial scar which is directed forward. Hinge fragments are readily distinguished by (1) the rounded anterior end, (2) the straight anterior pallial scar which is directed forward and dorsally slightly farther from the anterior margin than ventrally, (3) the long horizontal teeth which are as long as the anterior pallial scar to about as long as the breadth of the shell, and (4) the anteriorly straight ventral pallial scar.

Material. – NETHERLANDS: Bergen (N.H.), 2 fr., Eemien (GD). Otherwise numerous odd valves and fragments from Scheveningen beach, where this form is commonly washed ashore; also valves and fragments from several places all along the Dutch coast.

6. *Ensis* cf. *rollei* Hoernes, 1870
fig. 14

Ensis Rollei Hoernes, 1870: 15, pl. 1 figs. a-d.
Ensis cf. *Rollei*, Cossmann & Peyrot, 1909: 151, pl. 4 figs. 12-14?

Shell small, anterior breadth up to about 5.5 mm, slender, straight, or the hinge-region slightly turned upwards, anterior end rounded.

Hinge. – Horizontal teeth about $\frac{1}{3}$ of the length of the ligament or slightly longer, shorter than the anterior pallial scar or of about the same length at most; hinge subterminal.

Muscle scars. – Anterior pallial scar (a) slightly closer to the anterior margin than the ventral pallial scar to the ventral margin, (b) at the same distance from the anterior margin as the ventral pallial scar from the ventral margin, or (c) farther inwards, that is farther from the anterior margin than the ventral pallial scar from the ventral margin; the anterior pallial scar slightly diverging from the anterior margin downwards and ventrally farther from the anterior margin than dorsally, usually slightly directed forwards, though perhaps it may also be perpendicular; ventral pallial scar under the anterior adductor either curved (convex) or straight, but then diverging in relation to the dorsal shell margin. Anterior adductor scar long, up to twice the length of the ligament, slender, slightly tapering towards the top if at all, otherwise of about uniform width.

Dimensions. – Shell small, anterior breadth up to 5.5 mm.

Variability. – The main variation is in the position of the anterior pallial scar, described under the muscle scars. This is a rather uncommon type of variation in *Ensis* species, the position of the anterior pallial scar usually being a stable feature and in some cases even a diagnostic character.

Specific distinction. – The only species, that may be confused with *E. rollei* is *E. degrangei*, also occurring in the Miocene. Differences are (1) the anterior pallial scar which is never sloping backwards in *E. rollei*, (2) the rib, which is absent in *E. rollei*, (3) the more slender and longer anterior adductor scar of *E. rollei*.

Note. – One of the samples in the Vienna museum (see below), kindly sent to me by Dr. O.E. Paget, also contains nine fragments with aberrant characters. The anterior pallial scar in these specimens is perpendicular, or in one or two fragments, slightly sloping backwards, the horizontal teeth are much longer (about as long as the anterior pallial scar and nearly half the ligament), the anterior margin is rounded to a much lesser degree (in the fragment it even tends to be somewhat truncate), the anterior end thus not being exposed and the hinge terminal instead of subterminal. These characters neither agree with the numerous small *E. degrangei* from the Scaldisien, nor with those mentioned from the Miocene and Upper Oligocene. They bear some resemblance to *E. ensiformis*, but the long horizontal teeth and slightly rounded anterior end neither suggest this species. The material is too scarce and fragmentary, however, to allow of any definite conclusions.

Nomenclature. – The figure in Hoernes (1870) is that of a curved specimen with the ventral pallial scar decidedly closer to the ventral

shell margin than the anterior pallial scar to the anterior shell margin. In the material I have examined the ventral pallial scar is less close to the ventral margin and the fragments all seem to be of straight or nearly straight specimens. I cannot explain these differences, unless the aberrant fragments mentioned below should be true *E. rollei* and the material described here a different species. It is also for this reason, that I have presented the species here as *Ensis* cf. *rollei* Hoernes.

Material. – Miocene. NETHERLANDS:Belfeld, 58E/91, 175 m., 1 fr. (GD). AUSTRIA: 3 samples from the Naturhistorisches Museum, Vienna: Grund, 1859, 18 fr.; do., 1865, 6 fr.; Grund or Guntersdorf, 24 fr. (also 9 aberrant fr., see above).

SUMMARY

The above paper treats the fossil species of the genus *Ensis* in the Netherlands, while at the same time giving a survey of those of the Belgian Scaldisien/Merxemien. *Ensis waltoniensis* nom. nov. has been introduced for *Ensis ensiformis* J.D.C. Sowerby, 1844 (plate) and 1846 (description) non *Ensis ensiformis* Conrad, 1843. The following species are discussed: *Ensis complanatus* Sow., 1844, *E. waltoniensis* nom. nov., *E. degrangei* Cossm. & Peyr., 1909, *E. arcuatus* (Jeffr, 1865) s.s. and forms nos. 1 and 2, *E. ensis* (L., 1758), and *E.* cf. *rollei* Hoernes, 1870, all illustrated.

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SAMENVATTING

Bovenstaand artikel behandelt de Nederlandse fossiele soorten van het geslacht *Ensis*. Voor het determineren wordt een nieuw type tabel (zie Leenhouts, 1966) gebruikt, die ook voor fragmentarisch materiaal blijkt te voldoen. Voor de terminologie zie men fig. 1. De tabel werkt als volgt. Stel dat we de soort van fig. 7 willen determineren. No. 1 van de tabel leidt naar a) Voorrand afgerond, wat voorkomt bij soorten no. 1, 3, 4b, 5, 6 (voor de nummers van de soorten zie men onderstaande lijst). No. 2 van de tabel leidt naar a) Voor-mantellijn terugwijkend, wat voorkomt bij soorten (1), 2 en 3. Als een cijfer tussen haakjes geplaatst is, geeft dat aan dat het kenmerk wel eens bij de soort in kwestie voorkomt, doch niet regelmatig. De gemeenschappelijke soortnummers (1 en 3) verwijzen dus naar soorten die de combinatie van beide kenmerken (1a en 2a) (kunnen) bezitten. Dit zijn volgens de lijst soorten no. 1, *E. complanatus* en 3, *E. degrangei*. Op deze wijze voortgaand zal men spoedig op de juiste determinatie kunnen komen; dit is immers bereikt wanneer één soortnummer overblijft. In dit speciale geval zijn de kenmerken 4-6 van weinig of geen nut, maar 7 e.a. geven een betrouwbaar onderscheid tussen de twee genoemde soorten. Door het lezen van de verticale kolommen kan men ook een soortsbeschrijving krijgen, een beschrijving die de belangrijkste kenmerken opgeeft. Met een exemplaar in de hand kan men zo dus de determinatie controleren.

Bij de tabel verwijzen de cijfers in de verticale kolommen naar de volgende soorten: 1, *E. complanatus;* 2, *E. waltoniensis;* 3, *E. degrangei;* 4a, *E. arcuatus* s.s.; 4b, *E. arcuatus* forma no. 1; 4c, *E. arcuatus* forma no. 2; 5, *E. ensis;* 6, *E. rollei.*

1. Voorrand								
a. afgerond	1	–	3	–	4b	–	5	6
b. afgeknot	1	2	–	4a	–	4c	–	–
2. Voor-mantellijn								
a. terugwijkend	(1)	2	3	–	–	–	–	–
b. naar voren gericht	(1)	–	–	4a	4b	4c	5	6
c. loodrecht	1	2	(3)	4a	–	–	–	–

3. Voor-mantellijn								
a. dichter bij de voorrand van de schelp dan de onder-mantellijn bij de onderrand van de schelp	–	2	–	–	–	4c	5	6
b. op dezelfde afstand van de voorrand van de schelp als de onder-mantellijn van de onderrand van de schelp	1	–	(3)	4a	4b	4c	5	6
c. verder van de voorrand van de schelp dan de onder-mantellijn van de onderrand van de schelp	1	–	3	–	–	–	–	–
4. Voor-mantellijn								
a. boven- en onderaan op ongeveer gelijke afstand van de voorrand van de schelp	1	–	(3)	–	4b	4c	–	–
b. bovenaan dichterbij de voorrand van de schelp	–	2	3	4a	–	–	5	6
c. onderaan dichter bij de voorrand van de schelp	–	–	–	–	–	–	5	–
5. Voor-mantellijn								
a. naar binnen gebogen (concaaf)	–	–	3	4a	(4b)	–	–	–
b. recht	1	2	3	4a	4b	4c	5	6
6. Onder-mantellijn								
a. vooraan recht	1	(2)	–	4a	4b?	4c	5	6
b. vooraan naar boven gebogen (concaaf)	–	–	–	4a	4b?	4c	–	–
c. vooraan naar beneden gebogen (convex) (de buiging t.o.v. de onderrand van de schelp)	–	2	3	–	4b	–	–	–
7. Horizontale tanden								
a. korter dan de voor-mantellijn	1	–	–	–	–	–	–	–
b. ongeveer even lang als idem	–	2	3	4a	4b	4c	–	6

c. langer dan idem (tot ongeveer de breedte van de schelp)	–	–	3	–	–	–	5	–
8. Horizontale tanden								
a. ongeveer even lang als het ligament	–	–	3	–	–	–	–	–
b. ongeveer $\frac{1}{3}$ van het ligament	1	2	–	4a	4b	4c	5	6
c. ongeveer $\frac{2}{5}$ van het ligament	–	2	3	–	–	–	5	–
9. Voetretractor								
a. voor de ligament-inkeping (het eind van het ligament)	1	–	–	–	–	–	–	–
b. tegenover idem	(1)	2	3	–	4b	–	–	–
c. achter idem	–	2	3	4a	–	4c	5	6
10. Voorste spierindruksel								
a. even lang als het ligament of maar weinig langer	1	2?	–	–	–	–	–	–
b. tot ongeveer $1\frac{1}{2}$ x zo lang als het ligament	1	2	3	–	4b	–	–	–
c. duidelijk langer dan b	–	–	–	4a	–	4c	5	6
11. Schelpbreedte bij de voorrand								
a. meer dan 15 mm	1	–	–	–	–	–	–	–
b. 10-15 mm	1	2	3	4a	4b	4c	–	–
c. minder dan 10 mm	1	2	3	4a	4b	4c	5	6

Speciale kenmerken die niet bij een van de andere soorten voorkomen:

12. Een zwakke, maar goed waarneembare richel evenwijdig aan de voormantellijn	–	–	3	–	–	–	–	–
13. Voor-mantellijn sterk terugwijkend	–	–	3	–	–	–	–	–

14. Fijne groeven op de bovenkant van de schelp bij de voorrand	1	–	–	–	–	–	–	–
15. Voorste spierindruksel nauwelijks langer dan het ligament	1	2?	–	–	–	–	–	–