

THE IDENTIFICATION OF BRITISH SPECIES OF THE GENUS *ENSIS* SCHUMACHER (LAMELLIBRANCHIATA)

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(Plate I and Text-figs. 1-5)

INTRODUCTION

Winckworth (1932) lists three British species in the genus *Ensis* Schumacher. Two of these, *E. ensis* (L.) and *E. siliqua* (L.), are recorded by Linnaeus in the genus *Solen*; the third, *E. arcuatus* (Jeffreys), was considered by Jeffreys (1863) to be a variety of *E. siliqua*. Winckworth has, however, raised it to specific rank, without giving any reasons. In the present paper Winckworth's classification is followed, a note on the validity of the species appearing at the end.

Examination of specimens in various collections has revealed the confusion that has arisen in the identification of the species of *Ensis*: consequently many records are unreliable. Identification has proved difficult partly on account of a dearth of good illustrations of the three species, and also through the lack of any diagnostic distinguishing characters. Although *E. siliqua* is illustrated in many works, there are few good drawings of *E. ensis*, and some (Sowerby, 1887, for example) have illustrated *E. arcuatus* as *E. ensis*. Forbes & Hanley (1853) have an engraving of *Solen ensis* var. *magna* (= *E. arcuatus*), but failed to illustrate *Ensis ensis*.

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I am grateful to the Linnean Society of London for allowing me to examine type specimens; and to Dr R. Tucker Abbott, Division of Mollusks, U.S. National Museum, for kindly supplying photographs of Jeffreys' original specimens of *E. arcuatus*.

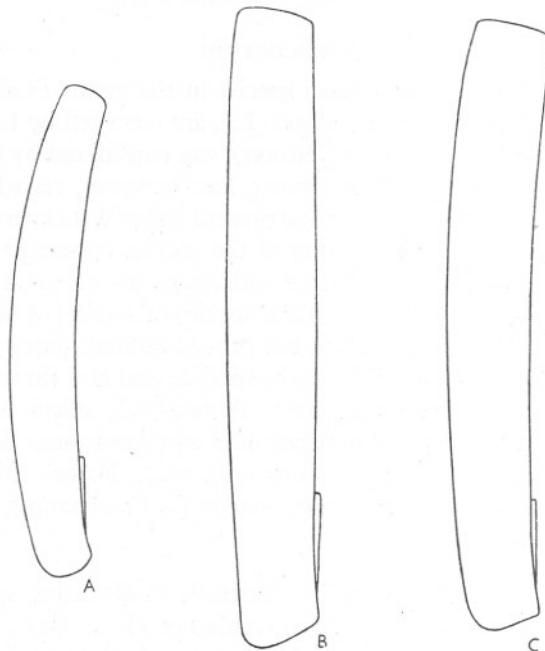
THE GENUS *ENSIS*

The genus *Ensis* comprises lamellibranchs with elongate equivalve shells, gaping at either end. The anterior end of the shell is not constricted, and the

hinge is terminal, having two teeth in the left valve, between which fits the single tooth of the right valve. There is a long external ligament. The two siphons are short and are surrounded by cirri. A fourth pallial aperture is present.

DISTINGUISHING CHARACTERS

In several of the distinguishing characters to be described there is some overlap owing to variation among individuals of a species. Consequently it is often necessary to employ all the available characters before a 'difficult' specimen can be identified.



Text-fig. 1. Outline of *Ensis* shells, $\times \frac{3}{5}$. A, *E. ensis*; B, *E. siliqua*; C, *E. arcuatus*.

The Shell

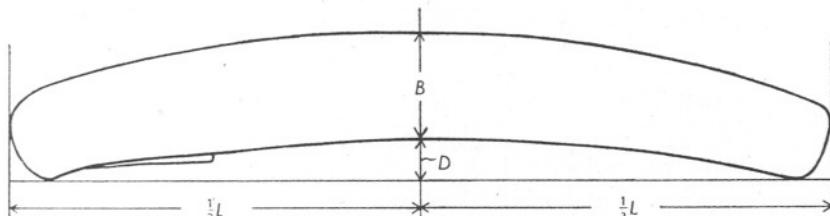
This remains the primary means of identification, both of the genus and species. The shell of *Ensis* is elongated along its anterior-posterior axis. Hence the pedal end is morphologically anterior, and the siphonal end is posterior. The long edge bearing the hinge is dorsal.

Length. The length attained by adult specimens differs in the three species. *E. siliqua* reaches a maximum of 20 cm., while *E. arcuatus* and *E. ensis* attain 15 and 10 cm. respectively. In many populations, however, these lengths are not reached, and Text-fig. 3 gives some indication of the lengths usually encountered.

Length/breadth ratio. Measurements of shell breadth are made as shown in Text-fig. 2. Results obtained from measurements of about 100 specimens from different localities are shown in Text-fig. 3, and summarized in Table I. The mean ratio is 6·80 in *E. siliqua*, 7·18 in *E. arcuatus*, and 7·80 in *E. ensis*. The range in proportions within each species is such, however, that there is some overlap between the species. In *E. siliqua* the shell tends to broaden in larger sizes, in *E. arcuatus* it remains fairly constant, whereas in *E. ensis* there is a tendency for it to become narrower.

Ford (1925) found a difference in the proportions of very small specimens of *E. ensis* and *E. arcuatus*. (He does not state, however, at what point the shell breadth was measured.) In *E. arcuatus* ranging from 7·5 to 21·0 mm. in length the mean ratio was 5·08, and in *E. ensis* ranging from 5·0 to 22·5 mm. the mean ratio was 6·44. Here again there was some overlap between the two species.

Thus the length/breadth ratio is not a reliable distinguishing character where only a few specimens from a population are available.



Text-fig. 2. Method of measuring breadth (*B*) and curvature (*D*) of an *Ensis* shell.

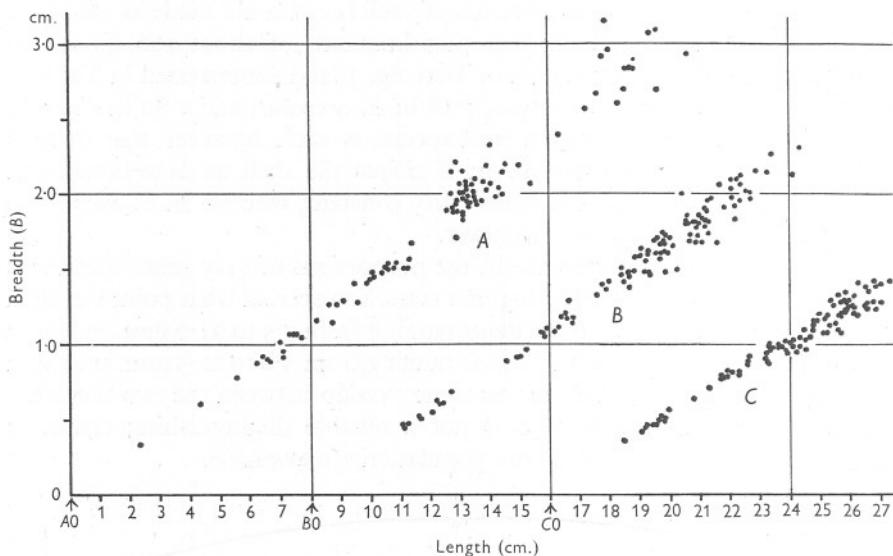
Curvature. The most obvious difference between the species is in the shell curvature. A measure of the curvature of the dorsal edge of the shell is obtained as shown in Text-fig. 2. The dorsal edge of a single valve is placed against a straight edge on a special measuring board, so that the two ends touch the edge. The ligament is cut away as necessary to allow this. In *E. siliqua* the shell usually touches at the anterior end and at a point just behind the mid-region, as the shell is often slightly convex on the dorsal surface. The distance *B+D* is measured by a vernier calliper, as is the breadth (*B*). '*D*' is then obtained by subtraction.

In *E. siliqua* most specimens are straight or slightly convex, (Text-fig. 4) giving a '*D*' of zero. '*D*' is not more than 0·1 cm. in normal specimens. Two very small specimens show some degree of curvature; this results in a slight curvature in the hinge region in adult specimens.

In *E. arcuatus* curvature is variable, some being as straight as slightly curved specimens of *E. siliqua*.

In *E. ensis* curvature is greater than in *E. arcuatus*, the plots of the two species scarcely overlapping.

It will be noticed that '*D*' becomes proportionately greater in large specimens. This is to be expected if the shells are growing in a curve approximating

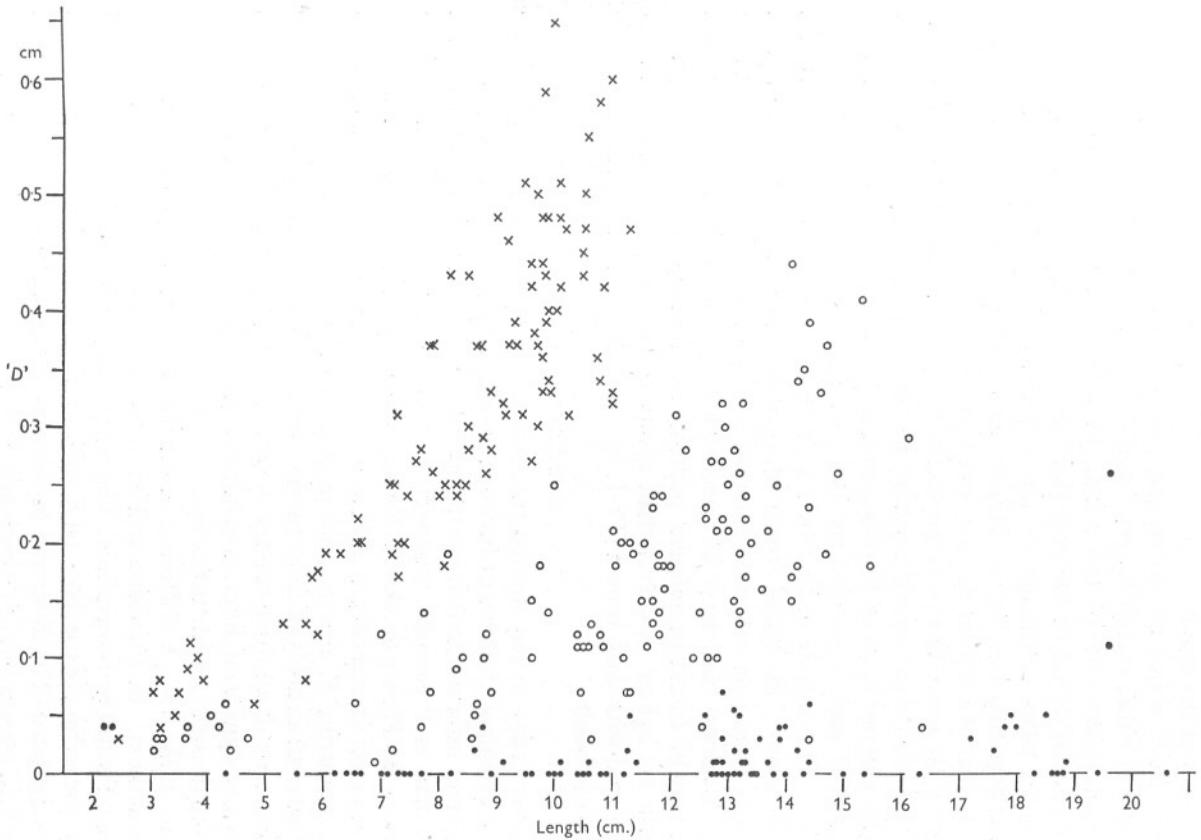


Text-fig. 3. Length-breadth relations of shells of *Ensis*: A, *E. siliqua*, 95 specimens from Broadlands, Torbay (6); Dale Roads, Milford Haven (6); Helford river, Cornwall (3); Millport (9); Paignton (59); Polesands, Exmouth (7); Salcombe (5). B, *E. arcuatus*, 112 specimens from Derbyhaven, Isle of Man (4); Eddystone shell-gravel (1); Grouville Bay, Jersey (10); Mewstone shell-gravel, Plymouth (1); Millport (3); Newton Haven, Northumberland (2); Salcombe, (52); Tresco, Scilly Is. (16); Yealm river (23). C, *E. ensis*, 101 specimens from Broadlands, Torbay (6); washed up on Dawlish Warren Beach (44); Grouville Bay, Jersey (5); St Aubin's Bay, Jersey (26); Salcombe (20). All shells are from material collected alive, except for some of those from Dawlish Warren Beach.

Note that the plots of A, B and C have different origins (indicated by arrows).

TABLE I

	Shell length (cm.)	Number examined	Length/breadth ratio		
			Mean	Maximum	Minimum
<i>E. siliqua</i>	0 - 4.0	1	7.06	—	—
	4.1 - 8.0	13	7.09	7.72	6.28
	8.1-12.0	21	7.06	7.54	6.74
	12.1-16.0	44	6.67	7.50	5.84
	> 16.0	16	6.55	7.26	5.66
	All sizes	95	6.80	7.72	5.66
<i>E. arcuatus</i>	0 - 4.0	6	6.92	7.16	6.49
	4.1 - 8.0	12	7.23	7.61	6.65
	8.1-12.0	46	7.20	8.29	6.71
	12.1-16.0	46	7.17	8.17	6.20
	> 16.0	2	7.32	7.56	7.08
	All sizes	112	7.18	8.29	6.20
<i>E. ensis</i>	0 - 4.0	11	7.20	7.64	6.83
	4.1 - 8.0	28	7.66	8.39	7.20
	8.1-12.0	62	8.01	9.07	7.25
	All sizes	101	7.80	9.07	6.83



Text-fig. 4. Measurements of shell curvature ('D', Text-fig. 2) against shell length. The shells are those used for breadth measurements in Text-fig. 3. \times , *E. ensis*; \circ , *E. arcuatus*; \bullet , *E. siliqua*.

to an arc of a circle. The points would then form part of an ellipse, the proportions of which would naturally vary according to the scale adopted for the two axes of the graph.

Taper. In *E. siliqua* the dorsal and ventral edges are almost parallel, with little taper at either end (Text-fig. 1 and Pl. I, fig. 1). In *E. arcuatus* there is some slight taper at the posterior end. In *E. ensis*, however, the ventral edge approaches the dorsal in the posterior third of the shell, producing a most pronounced taper. Although no measurements of taper have been made it would appear that the degree of taper in extreme specimens of *E. arcuatus* is similar to that of a typical *E. ensis*, and vice versa.

Shape of the ends. The posterior end of the shell in all three species is truncated, that of *E. ensis* being if anything a little more rounded than in the other two. The anterior ends of *E. siliqua* and *E. arcuatus* are similarly truncated, but that of *E. ensis* is rounded, as shown in Text-fig. 1.

Colour. The outside of the shell is divided diagonally into two areas of a different colour. The dorsal area is white or liver-coloured, while the ventral area varies from pale yellow to chestnut brown in colour. *E. ensis* is usually lighter in colour than the other species, but all shades from yellow to dark brown may be found in different populations of all three species. Small individuals are lighter in colour than adults from the same locality, and are often spotted with dark brown (Pl. I, fig. 2). The spots disappear or become indistinct in adults.

Soft Parts

Bloomer (1901-2) has studied the anatomy of *E. ensis* and *E. siliqua*. He found only minor differences between them, of little value in identification. Mr Bloomer informs me that his specimens were obtained from the Specimen Department at Plymouth. Since *E. ensis* is rare at Plymouth, most of the records in the *Plymouth Marine Fauna* (Marine Biological Association, 1931) being incorrect identifications of *E. arcuatus*, it seems possible that Bloomer was in fact comparing *E. arcuatus*, not *E. ensis*, with *E. siliqua*.

The internal anatomy of *Ensis* has not been examined in any great detail. The gross anatomy of all three species is very similar. Sections of the gills failed to show any significant differences in structure. Two characters have, however, been found useful for identification.

Colour of the foot. A difference in the colour of the foot has been noted by several authors. In *E. siliqua* and *E. arcuatus* it is creamy white in colour, reticulated with fine brown lines. The colour varies with the degree of distension or contraction of the foot. In *E. ensis* the foot is a pale reddish brown, and is also reticulated. The difference in colour is not great, but is useful in sorting out a mixed population of *E. ensis* and *E. arcuatus*.

The fourth aperture. In the posterior half of the body the mantle edges are fused ventrally, but anteriorly fusion is very weak, so that the mantle folds may be readily separated back as far as a small opening, the fourth aperture

(Text-fig. 5, A). The weak fusion is brought about by a cuticular junction of the mantle edges (Atkins, 1937).

Yonge (1948) believes the aperture to be a 'safety valve which permits the ventral extrusion of some of the water in the mantle cavity when these rapidly burrowing animals make the sudden muscular contractions involved in downward movement'.

The aperture is bordered by a row or rows of papillae, which interdigitate when the shell is closed. The papillae occur in about equal numbers on each side of the aperture. There is considerable variation in the number of papillae in each species, but *E. siliqua* tends to have more than the other two:

E. siliqua. Thirty-four specimens from Paignton, Devon. Number of papillae on one side of the opening: mean, 20·9; maximum, 40; minimum, 9.

E. arcuatus. Forty-two specimens from Tresco, Scilly Isles. Mean, 10·5; maximum, 26; minimum, 5.

E. ensis. Twelve specimens from St Aubin's Bay, Jersey. Mean, 12·0; maximum, 15; minimum, 8.

The species differ more in the form than in the number of papillae. In *E. siliqua* the papillae occur in more than one row, in a staggered arrangement. In small specimens they are simple (Text-fig. 5, G) but in those over about 7 cm. in length they are branched, or compound (Text-fig. 5, B, E and F). In side view they often resemble molar teeth. The form of the papillae can be distinguished with a lens in living specimens. Those illustrated in Text-fig. 5 are preserved in alcohol; the papillae do not seem to contract to any great extent in preserved specimens.

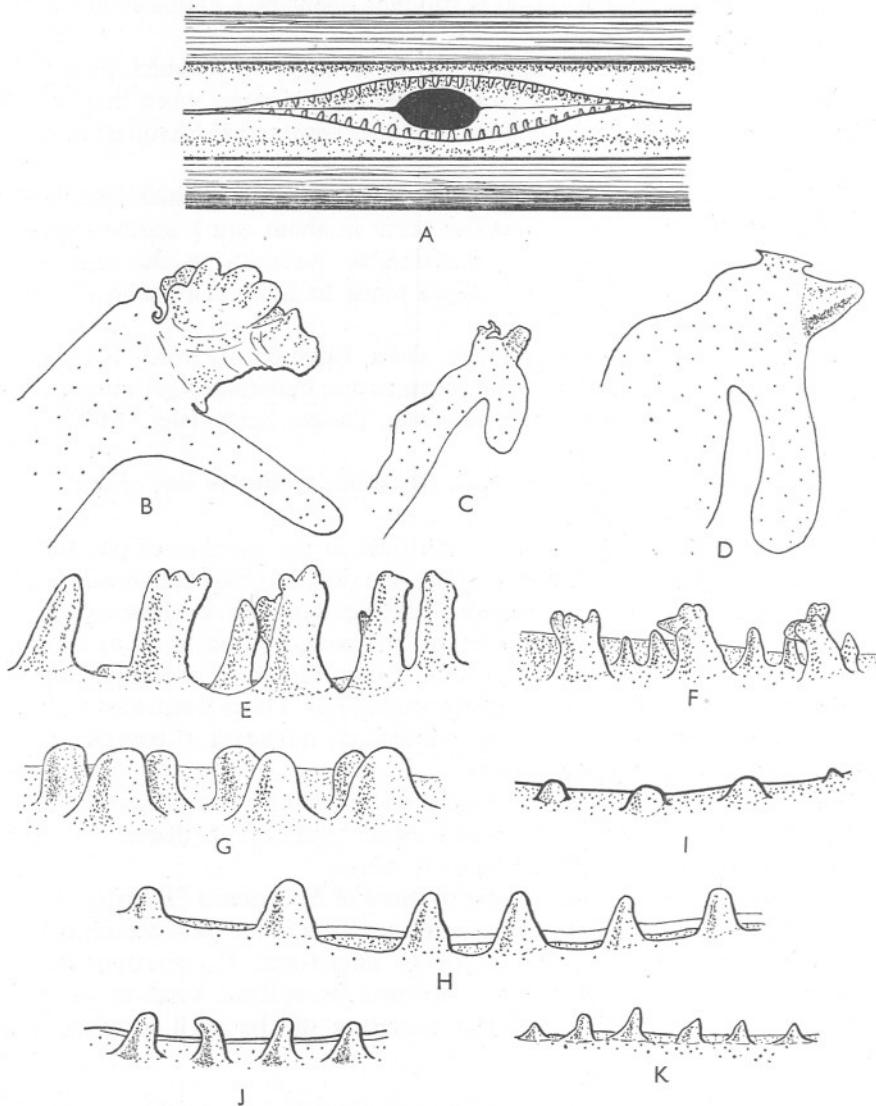
In *E. arcuatus* the papillae are simple, and in a single row (Text-fig. 5, H, I). Rarely, in large specimens, they may become bifid or club-shaped, but never assume the compound form typical of *E. siliqua*.

In *E. ensis* the papillae are similar to those of *E. arcuatus* (Text-fig. 5, J, K).

The form of the papillae of the fourth aperture is the only certain method of distinguishing adult specimens of *E. siliqua* and *E. arcuatus*. Certain separation is more difficult where specimens are still too small to show differences in these papillae, but the curvature of the shell is often some guide.

VALIDITY OF THE SPECIES

Constant morphological differences have been found between the three species of *Ensis*. These differences are slight however, and might be attributable to the effect of environment on a single species. *E. siliqua* occurs in clean sand at L.W.S.T., extending a little below extreme low-water mark. *E. arcuatus* lives in coarse sand or fine gravel at L.W.S.T., and extends out into deeper water. *E. ensis* inhabits bottoms of fine, sometimes slightly muddy, sand; rarely occurring on the shore. Thus the three species are not often found living together.



Text-fig. 5. Morphology of the fourth aperture. A, ventral view of the aperture in *E. siliqua*, $\times 4$. The shell is shown slightly gaping to reveal the mantle folds surrounding the opening. The anterior end is to the left. B-D, thick sections through the edge of the mantle opposite the aperture, the latter being on the right of the lip (lower right). A papilla (compound in *E. siliqua*) is shown top right. B, *E. siliqua*; C, *E. ensis*; D, *E. arcuatus*. All are $\times 19.5$. E-K, papillae viewed from inside the aperture, looking outwards: E, *E. siliqua*, length 15.0 cm., $\times 19.5$; F, *E. siliqua*, length 13.7 cm., $\times 19.5$; G, *E. siliqua*, length 7.0 cm., $\times 59$; H, *E. arcuatus*, length 14.75 cm., $\times 19.5$ (all papillae on one side shown); I, *E. arcuatus*, length 7.9 cm., $\times 19.5$; J, *E. ensis*, length 10.05 cm., $\times 19.5$; K, *E. ensis*, length 4.52 cm., $\times 19.5$.

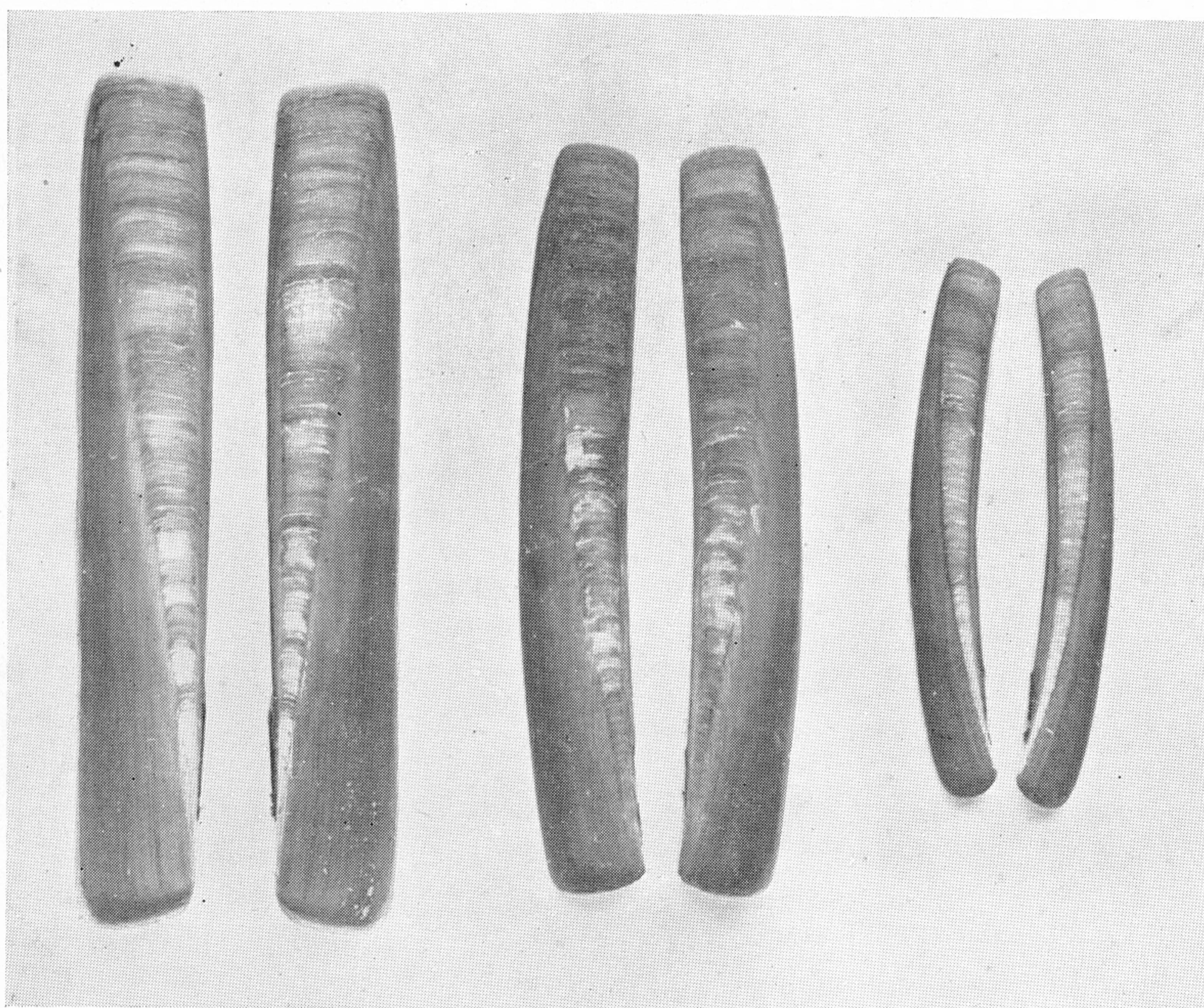


Fig. 1. Shells of adult *Ensis*. $\times 0.47$. Left to right: *E. siliqua*, *E. arcuatus*, *E. ensis*.

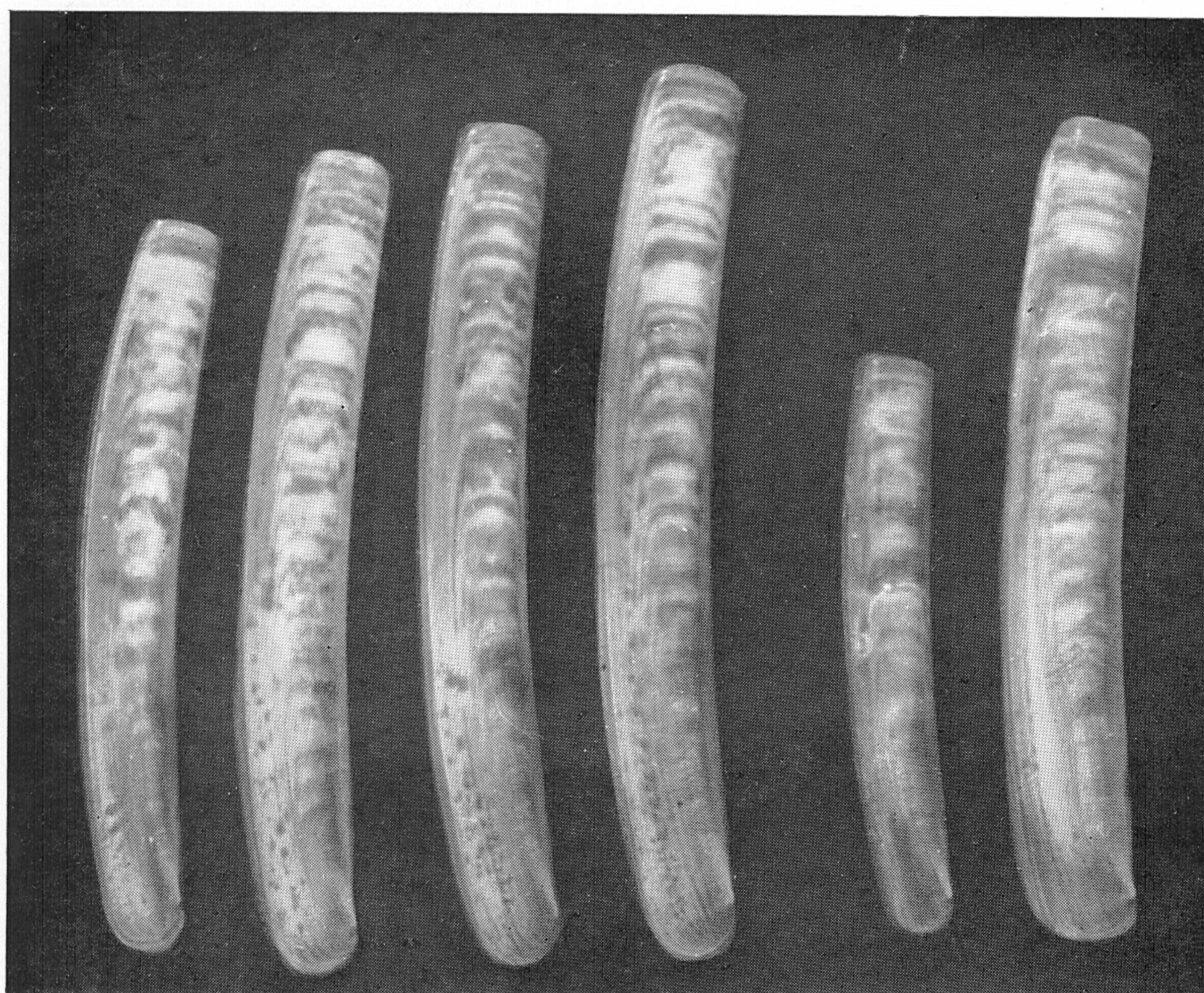


Fig. 2. Small individuals of *Ensis*. $\times 2.4$. Left: four specimens of *E. ensis* dredged in Whitsand Bay. Right: two specimens of *E. arcuatus* from the same locality. The foot may be seen projecting beyond the end of the shell in some of the specimens.

Occasionally, however, mixed populations have been found living in the same grade of soil in one locality. The following instances have been recorded:

E. siliqua living with *E. ensis*: Broadsands, Torbay, in fine sand.

E. siliqua living with *E. arcuatus*: south side of Millbay, Salcombe, in fine sand; Jeffreys (1863) records both species from Belgrave Bay, Jersey.

E. arcuatus living with *E. ensis*: in sand in St Aubin's Bay and Grouville Bay, Jersey, in Whitsand Bay, and in coarse muddy sand at Millbay, Salcombe.

Since the three forms maintain their distinctive characters when living together, it seems probable that they are separate species.

SUMMARY

The diagnostic characters of the British species of *Ensis* are described. The shell remains the primary means of identification, but additional characters in the soft parts are necessary for certain recognition. The three forms of *Ensis* described are considered to be valid species.

TABLE II. SUMMARY OF DISTINGUISHING CHARACTERS

	<i>E. siliqua</i>	<i>E. arcuatus</i>	<i>E. ensis</i>
Length of shell	20 cm.	15 cm.	10 cm.
Shell curvature	Straight	Slightly curved	More curved than in <i>E. arcuatus</i>
Taper of posterior end	None	Slight	Marked taper
Anterior end	Truncated	Truncated	Rounded
Foot colour	Cream-white	Cream-white	Pale red-brown
4th aperture:			
Rows of papillae	Staggered	1 row	1 row
Shape of papillae	Compound	Simple	Simple

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