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Some European Processidae (Crustacea, Decapoda, Caridea)

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Introduction

The European Processidae all belong to the genus *Processa* Leach, 1815 (= *Nika* Risso, 1816). Prior to 1936, only one species was generally recognized in this region, although some authors, notably Kemp (1910), had commented on the great differences between forms which they regarded as representing the extremes of specific variation. The first clear demonstration that more than one species was involved was provided by Lebour (1936) who showed that two species were present near Plymouth; she described these under the names *P. canaliculata* Leach and *P. edulis* (Risso). Later, after a thorough study of specimens from many localities, Nouvel & Holthuis (1957) recognized eight European species, one of these being further divisible into three subspecies. These authors considered that Lebour had misapplied the name *P. canaliculata*, and they attached it to a species which they regarded as being in better agreement with the illustration by Leach (1815). They redescribed the species which Lebour had called *P. canaliculata* under the name *P. mediterranea* (Parisi).

Allen (1961) questioned the status of the nominal species which Nouvel & Holthuis (1957) had called *P. canaliculata* and *P. mediterranea*, claiming that specimens captured off north-east England could not be satisfactorily identified using the key given by these authors. He regarded most of the points of distinction between the two forms as representing " extremes of a variation that is related to the growth of the shrimp " and came to the conclusion that *P. mediterranea* is a synonym of *P. canaliculata*.

Examination of specimens from the Irish Sea led the present authors to agree with Nouvel & Holthuis (1957) rather than Allen (1961) on the validity of the disputed species, and some additional distinguishing characters were noted. It was also felt that the northern and southern forms of one of these species differed sufficiently to merit a subspecific distinction. This paper was intended to put forward these views and to summarise the available records of species of *Processa* from waters around the British Isles. During its preparation, however, the second author examined the holotype of *Processa canaliculata* Leach, 1815, and found that it did not belong to the species described under that name by Nouvel & Holthuis (1957) but to their *P. mediterranea*. This meant that *P. mediterranea* is indeed a synonym of *P. canaliculata*, as claimed by Allen (1961) but for entirely different reasons. The revision of specific nomenclature necessitated by this discovery is included as the first part of this paper.

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New and revised specific names

Processa canaliculata Leach, 1815

Processa canaliculata Leach, 1815, pl. 41.
Nika cannelata Griffith & Pidgeon, 1833, pl. 17, fig. 2.
Nika Couchii Bell, 1848, p. 278, fig.
Nika edulis var. *britannica* Czerniavsky, 1884, pp. 59, 60.
Nika mediterranea Parisi, 1915, p. 65.
Processa prostatica Zariquiey Cenarro, 1941, p. 345, figs. 17–35.
Processa mediterranea (Parisi): Zariquiey Alvarez, 1955, p. 407. Nouvel & Holthuis, 1957, pp. 41–44, figs. 205–220.

Holotype: dried specimen, approximately 27 mm (tip of telson missing), in British Museum (Natural History), London, No. 270A, 'Coll. Montagu. Loc. Torcross, Devon. Det. W. E. Leach'. The rostrum and eyes are intact but are displaced by some damage to the front of the head. This damage and the broken tip of the telson are both mentioned by Leach (1815) and confirm the identity of the specimen. In all other respects it is in good condition.

The stylocerite, gills and pleopods could not be examined without damaging the specimen, but sufficient characters are clearly visible to leave no doubt that it is a juvenile of the species described by Nouvel & Holthuis (1957) as *P. mediterranea*. Particular mention may be made of the shape of the 5th and 6th abdominal pleura, the position of the anterior pair of spines on the telson relative to the transverse row of setae and the length and shape of the antennal scale. There is very good agreement on these and other points with the descriptions and figures of *P. mediterranea* by Nouvel & Holthuis (1957) and with Irish Sea specimens of the same species described and figured in the next section of the present paper as *P. canaliculata*.

Griffith & Pidgeon (1833) used the name *Nika cannelata* only in the caption of a plate, and the figure to which it refers appears to be a copy of that by Leach (1815) of *Processa canaliculata;* the specific name *cannelata* may have been a corruption of *canaliculata*. Czerniavsky (1884) mentioned *Nika edulis* var. *britannica* twice, each time clearly equating it with *Processa canaliculata* Leach. The names in question proposed by Griffith & Pidgeon (1833) and by Czerniavsky (1884) are therefore both regarded as junior objective synonyms of *Processa canaliculata* Leach.

Bell (1848) described his species *Nika Couchii* from a single specimen in which the "didactyl hand (was) shorter than the wrist; the former slightly, the latter more considerably, curved". No species of *Processa* is known in which the right first leg conforms to his description, and it seems likely that his specimen was slightly deformed in this respect. It was nearly 3 inches (75 mm) long, and the only species of the genus known to attain such a length is *P. canaliculata*. The long tapering antennal scale and the place of capture (Cornwall) are also fully consistent with synonymising Bell's species with Leach's.

The remainder of the synonymy given here is after Nouvel & Holthuis (1957) for *Processa mediterranea* (Parisi).

Processa nouveli **nom. nov.**

Processa canaliculata Leach: Holthuis, 1950, pp. 70–72, fig. 23; Nouvel & Holthuis, 1957, pp. 33–37, figs. 149–173. (non *Processa canaliculata* Leach, 1815).

Holotype: ovigerous female, 24·8 mm, illustrated Nouvel & Holthuis, 1957, figs. 149–153, 155–162, 164–167. Allotype: male, 25 mm, illustrated

Nouvel & Holthuis, 1957, figs. 168–173. Both in collection H. Nouvel, Toulouse. Collected by H. Nouvel, Monaco.

The figure of '*Processa canaliculata*' given by Holthuis (1950) is clearly based on a specimen of the species now under review, but his synonymy and mention of Lebour's specimen of 70 mm show that he did not at that time distinguish between it and the previous species. The two species were clearly distinguished by Nouvel & Holthuis (1957), who unfortunately attached Leach's name '*canaliculata*' to this, the wrong species. This species was described from Nouvel's material from Nice and Monaco; the type material is here designated from this material, and the species is named after this author. Recognition of a northern subspecies of *P. nouveli*, named after Holthuis, is proposed in a later section of the present paper.

The validity of *Processa nouveli* nom. nov.

Allen (1961) disagreed with Nouvel & Holthuis (1957) on the status of the two nominal species which they had described under the names *P. canaliculata* and *P. mediterranea*, here re-named *P. nouveli* and *P. canaliculata* respectively. His conclusion, based on the examination of North Sea material, was that only one species is involved and that a pseudo-specific distinction had been made between large and small specimens of this species. A study of Irish Sea material has led the present authors to agree with Nouvel & Holthuis (1957) rather than Allen (1961) on this point, and the aim of the present section is to clarify the distinctions between the two species.

Material and methods

Material trawled in the Irish Sea by the first author between 1971 and 1973 includes nearly 1000 specimens of *P. nouveli* and 13 of *P. canaliculata* from 15–20 km north-west of Port Erin, Isle of Man, depth 70–125 m, and 50 specimens of *P. nouveli* from about 9 km west of Sellafield, Cumberland, depth about 30 m. The substratum was mud in both areas.

One specimen of *P. nouveli* and four of *P. canaliculata* collected by Dr. R. B. Pike in 1958–60 near Millport, Firth of Clyde, were also examined, and Leach's holotype of *P. canaliculata* from south Devon (see previous section) is the smallest non-larval specimen of this species we have seen.

Where carapace length is given this refers to the measurement from the posterior part of the orbit to the posterior dorsal carapace margin. The term was defined rather differently by Allen (1961) to include the posterior lateral lobe of the carapace; his measurement is about 1·2 times that used here.

Distinguishing characters

Comparative drawings of some features of Irish Sea specimens of *P. nouveli* and *P. canaliculata* are shown in figs. 1 and 2, and the most convenient characters for their separation are summarized in table 1. The specimens drawn were chosen as being of similar size and undamaged. They are of different sexes, but none of the characters illustrated appears to show appreciable sexual dimorphism.

All the features listed in the table and illustrated in figs. 1 and 2 are also apparent in the figures provided by Nouvel & Holthuis (1957) or are mentioned

Comparison between Irish Sea specimens of *Processa nouveli* nom. nov. and *Processa canaliculata* Leach

	P. nouveli	*P. canaliculata*
Length:		
males	max. 41 mm	max. 67 mm
ovig. females	26–51 mm	52–74 mm
Rostrum:		
terminal teeth	dorsal $< 1/2$ ventral	dorsal $> 1/2$ ventral
profile	deepest near middle	deepest in post. half
Abdomen:		
5th pleuron	ventrally convex	ventrally straight
6th pleuron	prominent postero-ventral spine	short postero-ventral tooth
Telson:		
anterior spines	arise near transverse row of setae	arise well behind row of setae
Stylocerite	spine $> 0{\cdot}3 \times$ width	spine $< 0{\cdot}15 \times$ width
Antennal scale:		
margins	straight, nearly parallel	inner sinuous, outer slightly convex
width near tip	almost = max. width	about 1/2 max. width
length	similar to A_1 peduncle	longer than A_1 peduncle
Colour	red-purple, spotted	pink and orange-red, banded

in their detailed descriptions of the species. Some of these characters were also used to separate the two species in their key; some other characters employed in this key are discussed below. None of the characters in the table was considered by Allen (1961) in his table of comparative features of British species of *Processa*, although his paper included figures of the stylocerite and comments on the length of the spine.

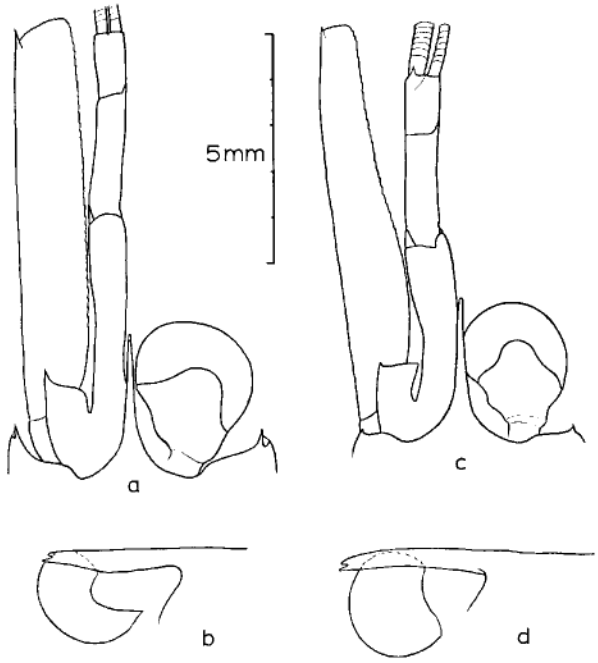

FIG. 1. (*a*), (*b*) *Processa nouveli* nom. nov., female, 51 mm. (*c*), (*d*) *Processa canaliculata* Leach, male, 46 mm. Dorsal views of head, lateral views of rostrum and eye. Setae omitted.

The length of the rostrum was not used as a distinguishing feature in the key given by Nouvel & Holthuis (1957) but their text and figures indicate a relatively short rostrum in Mediterranean specimens of *P. nouveli*, extending only a little beyond the inner posterior border of the cornea, while that of *P. canaliculata* extends to the front of the cornea or a little beyond. Allen (1961) found that in specimens of *Processa* from Northumberland waters the tip of the rostrum ranged from the level of the inner posterior margin of the cornea to that of the front of the cornea. Like other characters he examined,

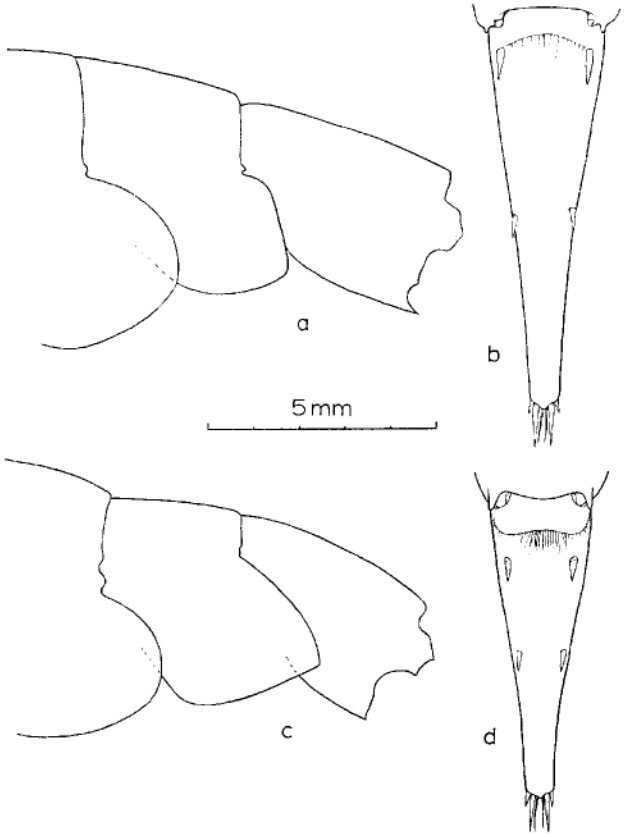

FIG. 2. (*a*), (*b*) *Processa nouveli* nom. nov., female, 51 mm. (*c*), (*d*) *Processa canaliculata* Leach, male, 46 mm. Lateral views of abdominal somites 4–6, dorsal views of telson. Setae omitted apart from transverse row on anterior telson and large pair near tip.

he did not consider it to provide a sound basis for specific distinction. No Irish Sea specimens of *P. nouveli* have been seen in which the rostrum is as short as in the Mediterranean specimens described by Nouvel & Holthuis (1957) or within the shorter part of the range given by Allen (1961). The range in length, measured from the posterior orbit, is 0·8–1·0 times that of the eye, while the corresponding range in Irish Sea specimens of *P. canaliculata* is 1·0–1·1 times. The rostrum of *P. nouveli* is thus usually shorter than in *P. canaliculata*, but the character does not provide a clear point of distinction

in all cases. The dorsal surface of the rostrum is always straighter in Irish Sea specimens of *P. nouveli* than *P. canaliculata*, although the dorsal tip curves slightly downwards in some specimens. The ventral surface of the rostrum was distinctly convex in all specimens of *P. nouveli* examined, making the rostrum deepest at about half its length. The majority of specimens of *P. canaliculata* showed no ventral bulge (as in fig. 1 (*d*)), but others showed a bulge in the posterior half. The difference in size between the two terminal teeth was consistently greater in *P. nouveli* than in *P. canaliculata*.

The lateral plaque on the 6th abdominal somite at its articulation with the telson was stated by Nouvel & Holthuis (1957) to bear a spine in the species here called *P. canaliculata* but not in *P. nouveli*. Allen (1961) showed the shape of this plaque to be subject to considerable variation. A clearer distinction between Irish Sea representatives of the two species is provided by the form of the postero-ventral angle of the pleuron of the same somite, which is produced into a prominent spine in *P. nouveli* as opposed to a short tooth in *P. canaliculata* (fig. 2 (*a*), (*c*)), but the illustrations given by Nouvel & Holthuis (1957) suggest that this difference may be less marked in Mediterranean specimens.

The position of the anterior pair of spines on the dorsal telson provides a very clear distinction between the two species which has not been considered by previous authors. In *P. nouveli* these spines arise in the anterior 1/8 of the telson, touching or very close to the transverse row of setae; in *P. canaliculata* they arise more than 1/5 the length of the telson from its anterior margin, with the transverse row of setae arising about midway between this margin and the bases of the spines. Specimens of *P. canaliculata* usually have a small median spine on the posterior margin of the telson, not present in *P. nouveli*, but the spine may be very inconspicuous, the tip of the telson is often damaged, and specimens in which the armature of the posterior telson was atypical of either *P. canaliculata* or *P. nouveli* were reported by Allen (1961).

Allen (1961) found considerable variation in the shape of the stylocerite in North Sea *Processa*, with the spine relatively short in large specimens. He appeared to regard the *nouveli* and *canaliculata* forms as representing extremes of a continuous variation. Figure 3 and fig. 1 (*a*) illustrate the variation in this appendage in Irish Sea specimens of *P. nouveli*. In spite of the range in shape, the length of the spine relative to the width of the stylocerite was always more than twice that in *P. canaliculata* in the specimens examined. The largest specimen for which a stylocerite was illustrated by Allen almost certainly belonged to *P. canaliculata*, the other five specimens to *P. nouveli*.

In all Irish Sea specimens of *P. nouveli* examined, the antennal scale was of about the same length as the antennular peduncle, ranging from slightly shorter to slightly longer; in all specimens of *P. canaliculata* it was distinctly longer. The shape of the scale differs considerably between the two species. In *P. nouveli* the inner and outer margins are straight and almost parallel throughout most of their length, while in *P. canaliculata* the curvature of the inner margin changes from markedly convex in the proximal half to slightly concave in the distal half and the outer margin is slightly convex in the distal half. The widest region occurs at about 1/3 the length of the scale in *P. canaliculata* and the distal part is much narrower than in *P. nouveli* (fig. 1 (*a*), (*c*)).

Nouvel & Holthuis (1957) claimed that an arthrobranch was present at the base of the 1st leg in the species here called *P. canaliculata* but not in *P. nouveli*, although a tubercle could be present in place of the gill in the latter species. Allen (1961) found that in his North Sea material an arthrobranch could be present, rudimentary or absent and no satisfactory separation into species on this basis was possible. In Irish Sea material a well-developed arthrobranch was present only in specimens of *P canaliculata* but a rudiment occurred in some specimens of *P. nouveli*. This character provides a fairly clear distinction between large specimens of the two species in this area, but no specimens of *P. canaliculata* of less than 46 mm were available, and the separation of smaller specimens on this feature may well be difficult.

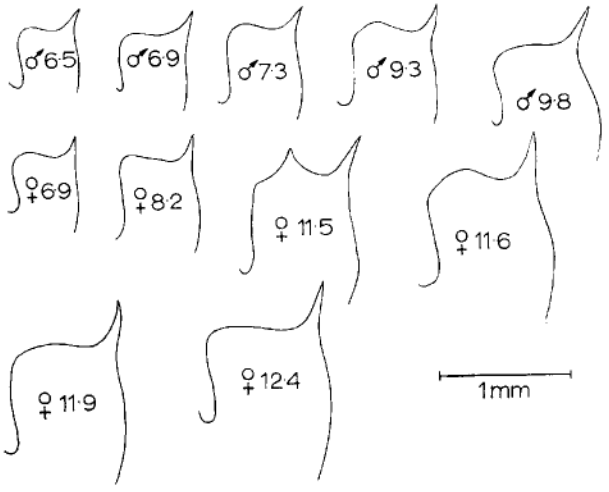

FIG. 3. Variation in shape of stylocerite in Irish Sea specimens of *Processa nouveli* nom. nov. Numbers refer to carapace lengths in mm.

Further characters used to separate *P. nouveli* and *P. canaliculata* in the key given by Nouvel & Holthuis (1957) were based on the numbers of segments in the merus and carpus of the second pair of legs, the numbers being different in the left and right appendages of both species. There are discrepancies between the numbers of segments given in the key and those in the text, but whichever set of figures is taken there appears to be some specific overlap except for the carpus of the right second leg. In the Irish Sea material examined, only one specimen of *P. nouveli* had a segment number for the right second carpus within the range found for *P. canaliculata* (fig. 4). There were, however, only seven specimens of *P. canaliculata* in which this appendage was intact, and had more specimens, particularly small ones, been available the overlap might have been greater. It will be seen (fig. 4) that the number of segments in the right second merus does not provide a specific distinction.

The numbers of spines on the merus of the 3rd and 4th legs appear from the text of Nouvel and Holthuis (1957) to show specific differences between the two species and were quoted in Allen's comparative table. Irish Sea specimens of *P. nouveli*, however, showed 4–7 and 4–9 spines on the merus of the 3rd and 4th legs respectively, while the corresponding figures for *P. canaliculata*

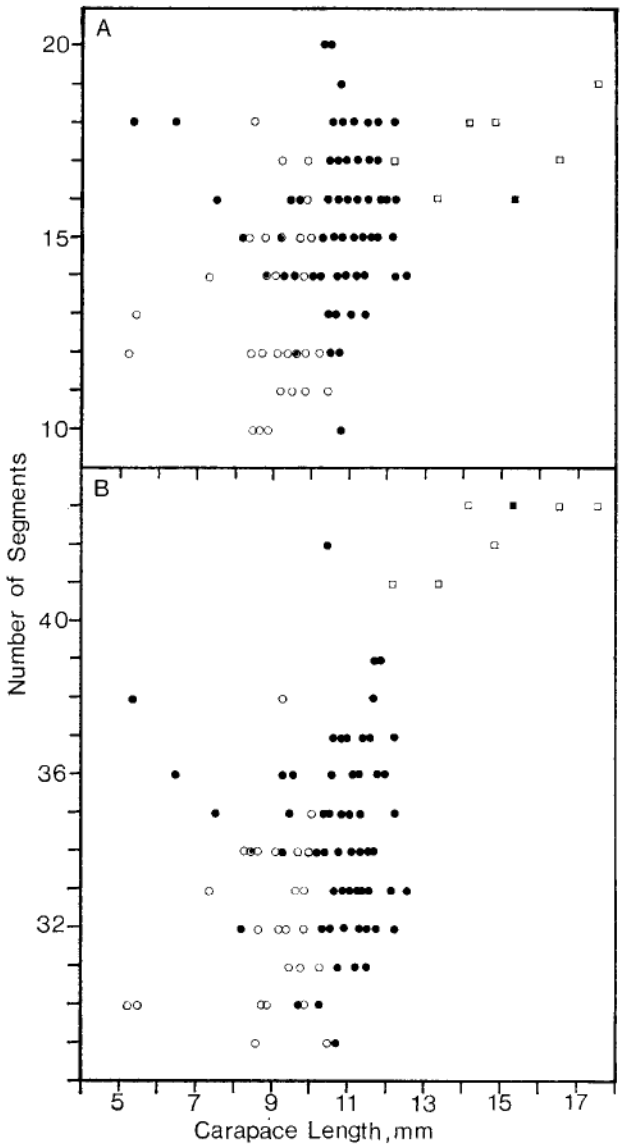

FIG. 4. Number of segments (A) in merus and (B) in carpus of right second leg related to carapace length in *Processa nouveli* nom. nov. (○ male, ● female) and *Processa canaliculata* Leach (□ male, ■ female).

were 6–7 and 5–7. As found by Allen for North Sea specimens, the character does not permit the separation of the two species in this area.

While *P. nouveli* and *P. canaliculata* may be separated on the characters used in table 1, no clear separation can be made on the characters used by Allen (1961). The absence of mature specimens of *P. canaliculata* in Allen's material probably contributed to his conclusion that he was dealing with a single species. Some of the specimens examined by him can, however, now be referred to *P. canaliculata*, particularly those illustrated in his figs. 3 (*e*), 6 (*d*) and 7 (*c*), although the great majority belonged to *P. nouveli*.

Subspecies of *Processa nouveli* nom. nov.

The description of '*P. canaliculata*' (= *P. nouveli*) by Nouvel & Holthuis (1957) was based on Mediterranean specimens from the region of Nice and Monaco. These are similar to Irish Sea specimens of the same species in most respects, but the Mediterranean form is very much smaller and shows some differences in the rostrum and eye.

We consider that the Mediterranean and northern forms should be recognized as subspecifically distinct, and we therefore propose the following subspecies:

***Processa nouveli nouveli* nom. nov.**

Processa canaliculata Leach: Nouvel & Holthuis, 1957, pp. 33–37, figs. 149–173. (non *Processa canaliculata* Leach, 1815).

Holotype and allotype as for species (see earlier section).

The following characters, which apply to specimens from the Nice–Monaco region, are taken from Nouvel & Holthuis (1957).

Length: males up to 25·5 mm, ovigerous females 22–29 mm.

Length of eye (from posterior orbit) at least 1·33 times that of rostrum, about 0·8 times that of proximal segment of antennular peducle. Width of eye in dorsal view 2·0–2·6 times that of antennal scale.

***Processa nouveli holthuisi* subsp. nov.**

Processa canaliculata Leach: Holthuis, 1950, pp. 70–72, fig. 23. (non *Processa canaliculata* Leach, 1815).

Holotype: female, 43 mm. Allotype: male, 39 mm. British Museum (Natural History), London, Nos. 1974 : 596 and 597. Collected A. H. Y. Al-Adhub, 21. ii. 72, 20 km north-west of Port Erin, Isle of Man, depth 90 m.

The following characters apply to Irish Sea specimens.

Length: males up to 41 mm, ovigerous females 26–51 mm.

Length of eye 1·0–1·25 times that of rostrum, about 0·6 times that of proximal segment of antennular peduncle. Width of eye in dorsal view 1·5–1·8 times that of antennal scale. The spine at the postero-ventral angle of the 6th pleuron is more acute than in the typical subspecies.

These characters apply not only to large shrimps which are well outside the size-range of *P. nouveli nouveli* but also to smaller specimens, including juveniles of less than 20 mm.

Records of *Processa* from northern Europe

Apart from changes in nomenclature resulting from proposals in the previous sections, nothing can at this stage be added to the records of species and subspecies of *Processa* from southern Europe given by Nouvel & Holthuis (1957). In northern Europe, however, specimens examined during the present work and a re-examination of some earlier records permit some further contributions, particularly regarding the distribution of *P. canaliculata* and *P. nouveli holthuisi* in waters round the British Isles.

Larval records can give information on the distribution of *P. parva* Holthuis and *P. canaliculata*, whose larvae are quite distinctive. Recent work by Miss

T. Rochanaburanon (in preparation) makes it possible also to identify the larvae of *P. edulis* and *P. nouveli*, but these have not previously been separated.

The most northerly record of the genus is from southern Norway (Kemp, 1910) but it is not possible to say which species was taken. The four forms known to occur in northern Europe are considered in turn; records from southern Europe or further south are omitted.

(1) *Processa edulis* (Risso) subsp. *crassipes* Nouvel & Holthuis

A few specimens taken in Port Erin Bay during the present work confirm the presence of this subspecies in the Irish Sea. It is occasionally fairly common (Bruce *et al.* 1963).

Other records are from the south-west Netherlands, north-east France and south-west Scotland (Nouvel & Holthuis, 1957) and from western Ireland (O'Ceidigh, 1962). The female of 45 mm from Bofin Harbour, western Ireland described by Kemp (1910), probably also belonged to *P. edulis crassipes*.

(2) *Processa parva* Holthuis

The most northerly records are of larvae from the Dogger Bank, North Sea (Rees 1952, 1955, as *P. aequimana*) and Kilkieran Bay, western Ireland (O'Ceidigh, 1962). Adults have been recorded from the Dutch and Belgian coasts and from Finistère, France (Nouvel & Holthuis, 1957). Neither adults nor larvae have been taken in the English Channel or Irish Sea.
(except Finistère)

(3) *Processa nouveli* nom. nov. subsp. *holthuisi* nov.

The present work shows *P. nouveli holthuisi* to be common in the Irish Sea to the west of the Isle of Man and off the Cumberland coast and it establishes its presence in the Firth of Clyde (berried female from near Millport, collected by Dr. R. B. Pike). Specimens from the Northumberland coast sent by Dr. Allen to the second author agree in every respect with Irish Sea material. The form from the central and southern North Sea, recorded by Holthuis (1950) as *P. canaliculata*, is probably the same. O'Ceidigh (1962) did not distinguish between this and the following species in his records from the west of Ireland.

(4) *Processa canaliculata* Leach

The female of 67 mm from the Irish Sea, described by Kemp (1910) as one of the forms of *P. canaliculata*, must almost certainly be referred to this species sensu stricto, and the Irish Sea record by Bruce *et al.* (1963, as *P. mediterranea*) is confirmed by further specimens taken to the west of the Isle of Man during the present work. Larvae were common off Port Erin throughout the autumn of 1973.

The four adult specimens collected by Dr. R. B. Pike near Millport, Firth of Clyde, and identified during the present work constitute the most northerly record of the species to date. As stated earlier, a minority of the specimens examined by Allen (1961) from off north-east England may now be referred to *P. canaliculata*. Records from south-west England include the holotype of *P. canaliculata* Leach, 1815 from Torcross, Devon, the holotype of *Nika couchii* Bell, 1848 from Cornwall, and adults and larvae from the Plymouth area correctly named by Lebour (1936).

Summary

The name *Processa canaliculata* Leach has been applied to a species other than that to which the holotype belongs. The species *P. canaliculata* Nouvel & Holthuis non Leach has no valid name; it is re-named *P. nouveli*, with type material from Monaco.

P. nouveli and *P. canaliculata* have been considered to be conspecific by one recent author. New characters for their separation are described from Irish Sea material.

The northern form of *P. nouveli* differs from the Mediterranean form sufficiently to be placed in a separate subspecies. The name *P. nouveli holthuisi* is proposed for it, with type material from the Irish Sea.

The distribution of the four species and subspecies of *Processa* known to occur in northern Europe is reviewed.

Acknowledgments

The authors are grateful to Dr. R. W. Ingle for facilities to examine Leach's holotype of *P. canaliculata* in the British Museum and for help in obtaining older literature, to Professor H. Nouvel for making his specimens available as type material of *H. nouveli*, to Professor Dr. L. B. Holthuis for his advice on synonyms, and to Dr. J. A. Allen for specimens and for his comments on the text.

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