

Taxonomic comments on subfamily Ostreinae Rafinesque

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Abstract. In the light of the present authors' work on subfamily Ostreinae from the Cretaceous of India, it was felt desirable that the two informal groups non-incubatory and incubatory genera of Stenzel in this Subfamily, be raised to the status of tribes as Crassostreini and Ostreini respectively on par with tribe Flemingostreini Stenzel. Also two new non-incubatory genera *Cussetostrea* and *Soleniscostrea* are proposed here based on the type species as *Crassostrea cusseta* Sohl and Kauffman and *Crassostrea soleniscus* (Meek) respectively.

Keywords. Crassostreini; Ostreini; new genera; *Cussetostrea*; *Soleniscostrea*.

1. Introduction

In the *Treatise* on oysters, Stenzel (1971) divided the subfamily Ostreinae into a tribe Flemingostreini and two other informal groups of (i) nonincubatory genera and (ii) incubatory genera. Of these two groups, the former included the genera *Acutostrea* Vyalov, *Crassostrea* Sacco, *Pseudoperna* Logan, *Saccostrea* Dollfus and Dautzenberg, and *Striostrea* Vyalov; and the genera *Ostrea* Linné, *Cubitostrea* Sacco, *Ferganea* Vyalov, *Platygena* Romanovskiy, and *Sokolowia* J. Boehm, have been assigned to the latter group.

Prior to the work of Stenzel, mutual relationships of several oystriid species were not clearly understood, and that resulted in often lumping together unrelated species.

Though Stenzel (1971) characterised various genera of this subfamily the authors' work on oysters from the Cretaceous of India, indicated that some of the species would still need to be placed in some new genera for their proper understanding. Chiplonkar and Badve (1976, 1978) erected two nonincubatory genera, viz. *Indostrea* and *Bosostrea* to accommodate some of the species from Bagh Beds. It was also realised that *Crassostrea cusseta* Sohl and Kauffman (1964) and *Crassostrea soleniscus* (Meek) (Stephenson 1952) do not belong to *Crassostrea* Sacco as defined by Stenzel (*Op. Cit.*). Therefore, two new non-incubatory genera, *Cussetostrea* and *Soleniscostrea* are proposed here to accommodate them respectively.

Further, evaluation of the morphological characters and the incubatory breeding habits of the members of Ostreinae the authors consider that the two informal groups of (i) nonincubatory genera and (ii) incubatory groups of Stenzel need to

be upgraded to the rank of tribes so as to bring them *on par* with the tribe Flemingostreini Stenzel.

2. Systematics

2.1. Proposed classification of subfamily Ostreinae

The proposed new classification of subfamily Ostreinae is presented in table 1 which includes the two new tribes and two new genera proposed here and those erected earlier by Chiplonkar and Badve (1976, 1978).

Table 1. Subfamily Ostreinae—new classification

Family:	Ostreidae Rafinesque 1815		
Subfamily:	Ostreinae Rafinesque 1815		
Tribe:	Crassostreini New Tribe	Tribe Ostreini New Tribe	Tribe Flemingostreini Stenzel 1975
Genera:	<i>Crassostrea</i> Sacco, 1897	<i>Ostrea</i> (<i>Ostrea</i>) Linné, 1758	<i>Flemingostrea</i> Vredenburg, 1916
	<i>Pseudoperna</i> Logan, 1899	<i>Ostrea</i> (<i>Turkostrea</i>) Vyalov, 1936	<i>Ostreonella</i> Remanovskiy, 1890
	<i>Saccostrea</i> Dollfus and Dautzenberg, 1920	<i>Cubitostrea</i> Sacco, 1897	<i>Odontogryphaea</i> Ihering, 1903
	<i>Acutostrea</i> Vyalov, 1936	<i>Sokolowia</i> J. Boehm, 1933	<i>Kokanostrea</i> Vyalov, 1936
	<i>Striostrea</i> Vyalov, 1936	<i>Ferganea</i> Vyalov, 1936	
	<i>Indostrea</i> Chiplonkar and Badve, 1976		
	<i>Bosostrea</i> Chiplonkar and Badve, 1978		
	<i>Cussetostrea</i> gen. nov.		
	<i>Soleniscostrea</i> gen. nov.		

Note : Stenzel (1975, p. N1150) suggested that *Anulostrea* Vyalov, 1936 and *Quadrostrea* Vyalov, 1936, could be ultimately placed in the tribe Flemingostreini, but as yet they are insufficiently known.

2.2. Diagnosis of new tribes

Subfamily : Ostreinae Rafinesque, 1815.

Tribe : Crassostreini new tribe.

Type genus : *Crassostrea* Sacco, 1897.

Diagnosis : Living forms nonincubatory with promayal passage; deep umbonal cavity under LV hinge plate; adductor scar pear shaped, drawn out dorso-posteriorly, reniform in *Saccostrea* and *Striostrea*; Ligamental area usually high to very high; shell outline elongate, spatulate to falcate, but ostreiform to rudistiform in adult *Saccostrea* and *Striostrea*; crowding over one another, incrusting or reef building.

Geological age : Lower Cretaceous to recent.

Tribe : *Ostreini* new tribe.

Type genus : *Ostrea* Linné, 1758.

Diagnosis : Living forms incubatory, no promaya passage and hence umbonal cavity under LV hinge plate less capacious; radial ribs on LV but never on RV; adductor muscle imprint usually reniform (except comma shaped to reniform in *Cubitostrea*); *Ferganea* homeomorphous with *Exogyra* and *Sokolowia* homeomorphous with *Gryphaea*; chomata present except in *Platygena*.

Remark : Though the authors have not studied this group, the above diagnosis is based on the characters mentioned by Stenzel (1971) for his informal group of incubatory genera.

The radial ornament on LV in case of most of the genera belonging to *Ostreini* is perceptibly strong, distinct and well developed than the one on LV of the genera of *Crassostreini*.

Geological age : Cretaceous to recent.

Thus these two tribes are erected to raise the status of Stenzel's informal groups of non-incubatory and incubatory genera belonging to subfamily *Ostreinae* Rafinesque.

2.3. *Diagnosis of new genera under tribe Crassostreini*

Genus : *Cussetostrea* gen. nov.

Type species : *Crassostrea cusseta* Sohl and Kauffman, 1964, *U.S. Geol. Surv. Prof. Pap.* 483: figures 5, 7, 10; Pl. 5, figures 1-4.

Diagnosis : Shell elongate, spatulate, very thick; posterior auricle usually developed; umbo flat, not prominent; beaks blunt; attachment area moderate to large; radial ornament totally absent, concentric lamellae unevenly spaced, coarse and numerous.

Adductor muscle mark comma shaped, postero-dorsal in position; muscle atrophied in old shells; ligamental area very tall, resilifer deep, broader than bourrelets; cardinal cavities present; chomata small slightly elongate extending upto mid-height of the shell, ventral ones rather weak.

Geological age : Upper Cretaceous.

Remarks : Compared to *Crassostrea* Sacco, the present genus, though closely allied to and apparently derived from it, however, differs on many count. Presence of chomata and postero-dorsal position of adductor muscle imprint are very distinctive characters of this genus. In addition to these, development of cardinal cavities, thick shell, absence of radial ornament further aid in differentiating this genus from *Crassostrea* Sacco *sensu stricto* (Stenzel 1971).

Genus *Bosostrea* Chiplonkar and Badve (1978, p. 106, figures 2-8, 15, 17, 21) from the Bagh Beds of India, shares with the present genus, elongate and spatulate shell and absence of radial ornamentation. But absence of chomata and cardi-

nal cavities, short ligamental areas, and comparatively thin smooth shell as in *Bosostrea* help in differentiating it from the present genus.

Ostrea pantagruelis as described and illustrated by Coquand (1869, p. 68, figures 1 and 2) from the European Cretaceous, also in the position of muscle mark, and absence of radial ornament, resembles the members of *Cussetostrea* (*vide supra*). However, mention was neither made to chomatal marks nor indicated by Coquand. If this feature is revealed on re-examination of material assigned to this species, it may have to be transferred to *Cussetostrea*; otherwise, it would need a new genus for its proper placement. In the light of our suggestion (*vide supra*) on the derivation of *Cussetostrea*, this species (possibly belonging to undescribed genus) may be a possible ancestor of *Cussetostrea*.

Genus : *Soleniscoostrea* gen. nov.

Type species : *Crassostrea soleniscus* (Meek).

Ostrea soleniscus Meek 1871: *Am. Philos. Soc. Proc.*, V 11, p. 430.

Ostrea soleniscus Meek: Stephenson, 1952, *U.S. Geol. Surv. Prof. Pap.* No. 242, p. 74, pl. 16, figures 1-4, Pl. 17, figures 7-10.

Diagnosis : Outline variable, but usually elongate, very narrow to spatulate, beaks exogyroid, posterior auricle rarely developed; concentric lamellae numerous closely spaced; fine radial costae on juvenile or moderately sized individuals; ligamental area higher than long, resilifer broader than bourrelets; chomata encircle the valve margin in juvenile stage.

Geological age : Upper Cretaceous.

Remarks : Postero-Ventral position of muscle mark, and not covered by nacreous layer, presence of radial ornament in juvenile and moderately sized individuals and non massive shell are some of the characters which help in distinguishing this genus from *Cussetostrea* gen. nov. (*vide supra*).

The present genus differs from *Bosostrea* Chiplonkar and Badve (1978, p. 106) in having radial ornamentation, presence of chomata and rather scabrous shell. In the case of closed shells of *Bosostrea* where absence of chomata cannot be ascertained, their smooth surface would be helpful in distinguishing it from the present genus.

The broad and triangular resilifer, absence of chomata, and well-developed radial ornamentation are the features of *Crassostrea* Sacco which aid in differentiating it from the present genus.

3. Discussion

Chomata are an evolutionary feature attained by oysters during their phylogeny, and is acceptable as such (Stenzel 1971, p. N 992). Their origin and precise function are, however, not yet properly understood. Therefore, while their taxonomic value is realised, their status amongst different taxonomic attributes for the present

may be considered as inferior to that of the adductor muscle mark, ligamental area, etc. (Stenzel 1971, p. N 992).

Here, an attempt has been made to evaluate the possible significance of chomata in classification of the genera assigned to the tribe Crassostreini. On the basis of chomatal characters the nine genera assigned to it fall into three distinct groups as follows:

(A) Chomata encircling entire valve margin :

- (i) *Indostrea* Chiplonkar and Badve
- (ii) *Saccostrea* Dollfus and Dautzenberg
- (iii) *Pseudoperna* Logan

(B) Partially developed chomata :

- (i) *Acutostrea* Vyalov
- (ii) *Striostrea* Vyalov
- (iii) *Cussetostrea* gen. nov.
- (iv) *Soleniscostrea* gen. nov.

(C) Chomata absent

- (i) *Crassostrea* Sacco
- (ii) *Bosostrea* Chiplonkar and Badve.

The above grouping of genera on the basis of chomata, however, is arbitrary, since other morphological characters such as adductor muscle mark, outline of the shell and ligamental area whose significance is already known, indicate different assemblages. For example, *Indostrea* and *Saccostrea*, in both of which well-developed chomata encircle the valve margins, they differ in characters like shape of muscle mark, shell outline, extent of the development of the ligamental area, ornament, etc.

Therefore, grouping of the genera on the basis of morphological characters of which considerable information is available appears more precise than to have them based on chomata.

Thus we have :

Group I

Morphological characters

<i>Indostrea</i> <i>Acutostrea</i> <i>Pseudoperna</i>	}	Postero-ventral position of comma-shaped adductor muscle mark; falcate or spatulate shell outline; moderately developed triangular ligamental area.
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Group II

<i>Striostrea</i> <i>Saccostrea</i>	}	Reniform muscle mark; ostreiform shell outline, rudist like adults with very elongate ligamental area.
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Group III

<i>Crassostrea</i> <i>Bosostrea</i> <i>Cussetostrea</i> <i>Soleniscostrea</i>	}	Spatulate or much elongate outline; comma shaped muscle mark with dorso-posterior end drawn out only; in case of <i>Cussetostrea</i> dorso-posterior in position; moderately elongate or fairly elongate ligamental area.
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Among these groups I and III appear closely related, and *Crassostrea* is probably the stock from which they have evolved. *Striostrea* and *Saccostrea* possibly have some other ancestry.

Considering that chomata developed in the same position though to a variable degree among these genera, they apparently served the same function. While their taxonomic value is admitted (Stenzel 1971, pp. N 992–N 994 and N 1095), their importance in taxonomy, relative to other morphological characters would, however, remain uncertain till more is known about them, and such information about them as may become available might help us to know better about the mutual relations among these genera.

4. Key to the tribes and genera

Subfamily *Ostreinae* Rafinesque, 1815: Non-incubatory or incubatory, Chomata present or absent, without pustules on internal surface along the valve margins.

This subfamily now includes three tribes namely, *Flemingostreini*, *Crassostreini* and *Ostreini*. The key is prepared to identify the tribes and the genera placed under individual tribes.

4.1. Key for tribes

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|---|------------------------------|
| 1. Terebratuloid fold on valve commissure at ventral valve margin | Tribe <i>Flemingostreini</i> |
| 1. Terebratuloid fold absent | |
| 2. Deep umbonal cavity under LV hinge plate | Tribe <i>Crassostreini</i> |
| 2. Shallow umbonal cavity under LV hinge plate | Tribe <i>Ostreini</i> |

4.2. Key for the genera under each tribe

Tribe *Flemingostreini*

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|------------------------------|----------------------|
| 1. RV operculate | <i>Kokanostrea</i> |
| 1. RV non operculate | |
| 2. Terebratuloid fold strong | <i>Odontogryphae</i> |
| 2. Terebratuloid low | |
| 3. Shell flat | <i>Flemingostrea</i> |
| 3. Shell biconvex | <i>Ostreonella</i> |

Tribe *Crassostreini*

- | | |
|---|---------------------|
| 1. Adductor muscle reniform | |
| 2. Chomata encircling valve margins | <i>Saccostrea</i> |
| 2. Chomata few, not encircling valve margins | <i>Striostrea</i> |
| 1. Adductor muscle not reniform | |
| 3. Adductor muscle dorsoposterior | <i>Cussetostrea</i> |
| 3. Adductor muscle posteroventral in position | |
| 4. Radial ribs totally absent | |
| 5. Chomata encircling valve margins | <i>Indostrea</i> |
| 5. Chomata absent | <i>Bosostrea</i> |

- 4. Radial ribs present
 - 6. Chomata absent *Crassostrea*
 - 6. Chomata present
 - 7. Commissural gutter distinct *Acutostrea*
 - 7. Commissural gutter absent
 - 8. Chomata numerous *Pseudoperna*
 - 8. Chomata few *Soleniscostrea*

Tribe *Ostreini*

- 1. Muscle mark central in position
 - 2. Shell convex; *Gryphaea* homeomorph *Sokolowia*
 - 2. Shell not convex
 - 3. Numerous fine radial ribs *Platygena*
 - 3. Radial ribs coarse
 - 4. Chomata inconspicuous *Ostrea (Ostrea)*
 - 4. Chomata conspicuous *Ostrea (Turkostrea)*
- 1. Muscle mark along the posterior margin
 - 5. Shell exogyroid *Fergania*
 - 5. Shell crescent shaped or triangular *Cubitostrea*

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