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Jolyna furcata sp. nov. (Scytosiphonales, Phaeophyceae) from the Sultanate of Oman[1]

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Abstract – A second species of the brown algal genus *Jolyna* Guimarães (Scytosiphonales, Phaeophyceae), *J. furcata*, is recognized based on several collections made from Dhofar, the Sultanate of Oman. The new species is distinguished from the type species, *J. laminarioides*, by its thinner, more narrow, smaller, and often furcate thalli, anatomical differences, and its occurrence in more protected habitats.

Arabian Sea / biogeography / *Jolyna* / *Jolyna furcata* sp. nov. / *Jolyna laminarioides* / marine brown algae / Scytosiphonales / Sultanate of Oman

Résumé – ***Jolyna furcata* sp. nov. (Scytosiphonales, Phaeophyceae) du Sultanat d'Oman.** Une deuxième espèce du genre d'algues brunes *Jolyna* Guimarães (Scytosiphonales, Phaeophyceae), *J. furcata*, est reconnue ; elle est basée sur plusieurs récoltes effectuées à Dhofar, Sultanat d'Oman. La nouvelle espèce se distingue de l'espèce type, *J. laminarioides*, par ses thalles plus minces, plus étroits, plus petits et souvent bifurqués, ainsi que ses différences anatomiques et ses biotopes plus abrités. (Traduit par la Rédaction)

algues brunes / biogéographie / *Jolyna* / *Jolyna furcata* sp. nov. / *Jolyna laminarioides* / mer Arabique / Scytosiphonales / Sultanat d'Oman

INTRODUCTION

The brown algal genus *Jolyna* was described by Guimarães (in Guimarães *et al.*, 1986) from near Cabo Frio, Brazil, and was based on the single species *J. laminarioides* Guimarães. The genus was known only from Brazil until it was reported from the Hadramout coast of Yemen, the northern Arabian Sea, by Wynne & Banaimoon (1990). At that time Wynne and Banaimoon (1990) asserted that earlier reports of *Endarachne binghamiae* J. Agardh from Pakistan (Nizamuddin & Farooqi, 1968) and Oman (Barratt *et al.*, 1986) and *Petalonia*

1. Dedicated to Susan Loiseaux-de Goër, who taught me how to obtain unialgal cultures of brown algae with her "hanging-drop technique" back in the early 1960's at University of California, Berkeley, and who has remained a steadfast friend ever since.

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fascia (O. F. Müller) Kuntze from Yemen (Banaimoon, 1988) were based on misidentifications and also belong to *Jolyna laminarioides*. The internal anatomy of *Jolyna* is more highly differentiated with a medulla composed of fiber-like cells in a matrix of interconnected filaments (Guimaraes et al., 1986), whereas *Petalonia* has a largely parenchymatous medulla of 2-4 (-6) cell layers and *Endarachne* has 1 (-2) layers of larger colorless outer medullary cells and an inner network of rhizoidal medullary cells (Fletcher, 1987; Stegenga *et al.*, 1997). Later, Silva *et al.* (1996) stated that a collection from Karachi, Pakistan, by J. Murray and reported by Biswas (1945) as the kelp *Phyllaria reniformis* [= *Phyllariopsis brevipes* (C. Agardh) E. C. Henry *et* South] also was *J. laminarioides*. Collecting expeditions in southern Oman, which were timed to occur at the end of the summertime monsoon, have led to the recognition of a second species of *Jolyna*, which occurs sympatrically with *J. laminarioides* but in a somewhat different habitat of the same shoreline. The morphological and ecological characteristics of the new species are described in this account.

MATERIALS AND METHODS

Three of the four collections of the new species were made in Sept. 2000 and Sept. 2001. The fourth collection was made in August of 1985. Specimens were easily collected in the attached state because of their occurrence in the supralittoral zone. Material was processed as herbarium mounts soon after collecting, some specimens being preserved in 5% Formalin/sea-water. For comparison, a wet-preserved specimen of *Jolyna laminarioides* was also examined. Its collection data are: Hatom Bay (16.96091° N, 54.82795° E), east of Mirbat, Dhofar 8.ix.2001, *leg. M. Wynne 08092001-03-18* (MICH). Small portions of wet specimens of both species or rehydrated pressed specimens were mounted on glass slides, hand-sectioned using a single-edged razor blade, and then observed with a standard Zeiss research microscope. Line drawings were made with a camera lucida attached to the microscope, and photomicrographs, using Kodak T-MAX 100 film, were made with a camera-back attached to the same microscope. Habit photographs were taken with a standard 35 mm camera. Coordinates were obtained in the field by using several GPS devices. The primary one used was a model made by Garmin Etrex Summit. Herbarium abbreviations are according to Holmgren *et al.* (1990).

OBSERVATIONS

Vegetative Structure

Thalli are attached as caespitose clumps with a small discoid holdfast and consist of strap-shaped blades, ranging in length from 20 to 45 cm and (3-) 6-13 mm in width. Thalli can be simple or divided one to three times (Fig. 1). Older blades sometimes bear marginal proliferations (to 5 cm in length) near the base (Fig. 2). Older specimens do not adhere to paper when pressed as readily as younger blades. Young thalli become greenish-brown and older specimens become dark brown after being dried in the press.

Blades measure 280-340 μm in thickness. Cross-sections reveal the anatomy to consist of cortical layers of small pigmented cells and a medulla of

Fig. 1. *Jolyna furcata* M. J. Wynne. Paratype specimen *(17092001-12-01)* in MICH. Scale bar: 5 cm.

Fig. 2. *Jolyna furcata* M. J. Wynne. Holotype specimen in MICH. Scale bar: 10 cm.

larger, colorless cells (Fig. 6). In the transition zone from subcortex to medulla, cells become larger and are irregularly rounded. In the innermost zone of the medulla are more elongate cells. Longitudinal sections show these innermost cells to form a network in a direction parallel to the long axis of the thallus (Fig. 3). Superficial tufts of hairs are absent.

There is a conspicuous presence of cells containing physodes (fucosan granules) (Fig. 6), which give these cells a golden-brown color. These cells are initiated at the surface as small cells, and later they appear to be sunken into the subcortex (Fig. 4). These cells containing physodes are ovoid to irregularly shaped, at their largest size reaching 16 µm in width and 26-46 µm in length.

Reproductive Structure

Fertile blades bear extensive soral regions of plurilocular organs on both surfaces (Figs 5 & 7). Plurilocular organs are 5-7 locules in depth and are usually uniseriate, sometimes partially biseriate.

Ecology

The three collections made by the author were all found attached on the tops of upper littoral to supralittoral boulders, being gently splashed by occasional waves. The clumps of this alga were exposed to the air but still moist to the touch. The two locations were inside narrow coves and were essentially protected from the full buffeting of the surf by their location. The collection made by Wrathall at Wadi Forh was reported to be from a 1-3 m. depth but in a "moderately exposed" site. The evidence points to *J. furcata* as being much less common than *J. laminarioides*, which is ubiquitous at extremely exposed rocky habitats of southern Oman, and restricted to more protected and higher littoral/sublittoral microhabitats.

Diagnosis: ***Jolyna furcata*** *M.J. Wynne sp. nov. Thalli caespitosi, haptero parvo discoideo et laminis ligulatis, 20-45 cm long. et (3-) 6-13 mm lat. Thalli simplex vel divisi, semel, bis vel ter; laminae veteriores interdum prope basem proliferationes marginales ferentes; ubi exsiccatae, thalli juvenes sunt virelli-brunnei, thalli veteriores fusco- brunnei. Laminae sunt 280-340 µm crass.; anatomia interna ex stratis corticalibus cellularum parvarum pigmentifarum et ex medulla cellularum grandiorarum incoloratarum constans; in regione intima medulla cellulae sunt elongatiores, plexum in directione parallelo ad axem longo thalli formantes; caespites superficiales pilorum adsunt. Cellulae 'physodes' continentes sunt conspicuae; hae cellulae ad paginam laminae atque cellulae parvae formatae, et postea eae sunt in medulla depressae; hae cellulae 'physodes' continentes sunt ovoideae vel irregulariter formatae, 16 µm lat. et 26-46 µm long. maxime. Laminae fertiles soros extensos organorum plurilocularorum in ambo paginis ferentes; organa pluriloculares sunt 5-7 locula in crass. et sunt plerumque uniseriata, interdum partiale biseriata.*

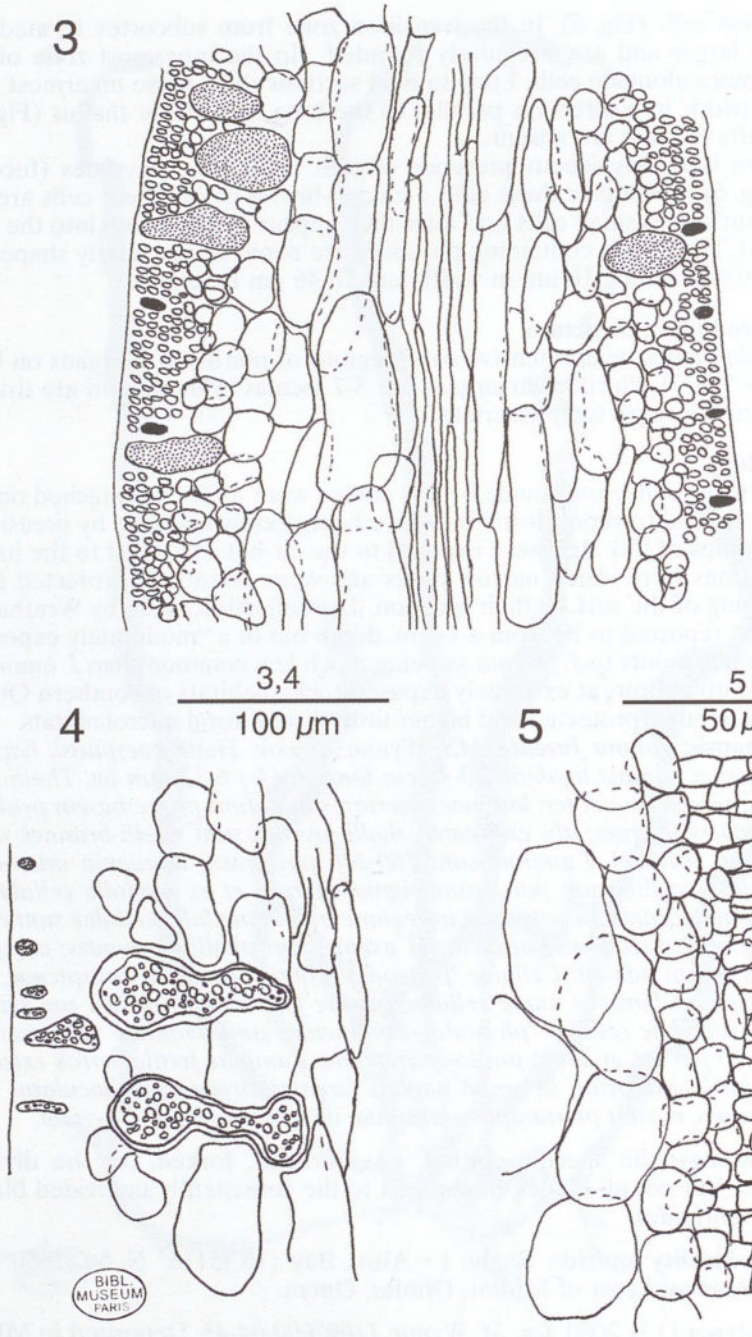
Etymology: the specific epithet, Lat. *furcatus*, forked, for the divided nature of some but not all blades, in contrast to the consistently undivided blades of *Jolyna laminarioides*.

Type locality: outside Raaha (= Alto) Bay (16.95116° N, 54.81650° E), east of Wadi Zeid and east of Mirbat, Dhofar, Oman.

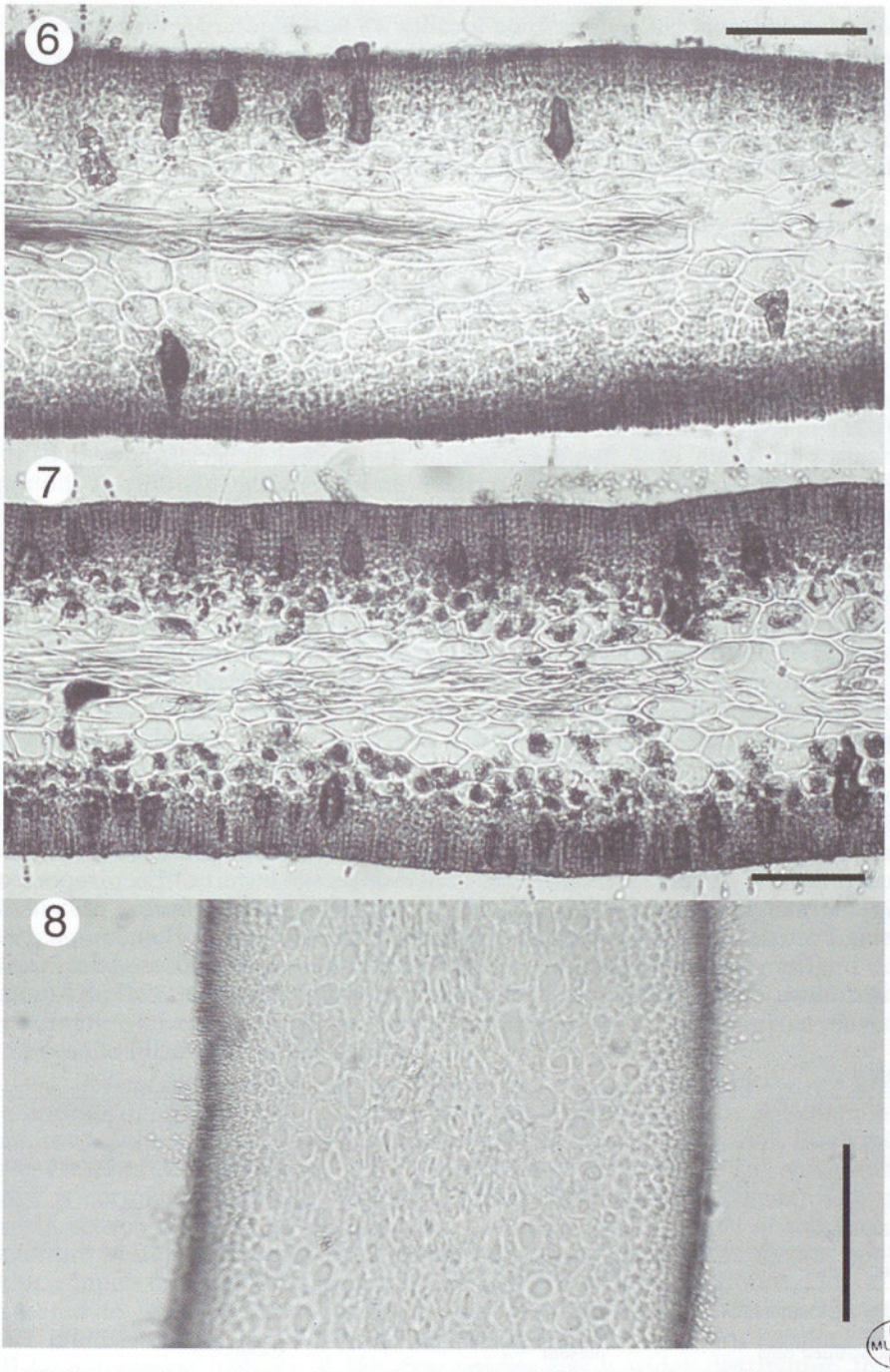
Holotype: 11.ix.2000, *leg. M. Wynne 11092000-04-43*. Deposited in MICH (Fig. 2).

Isotypes: Deposited in BM and ON.

Habitat: in clumps on the tops of wave-washed supralittoral boulders in a semi-protected cove.



Figs 3-5. *Jolyna furcata* M. J. Wynne. Camera-lucida drawings. Fig. 3. Longitudinal-section of blade, showing organization of cortex and medulla and the various sizes of the physode-filled cells (stippled or blackened). Fig. 4. Cross-section of blade, showing mostly the physode-containing cells and their location. Fig. 5. Cross-section of a fertile blade, with plurilocular organs and scattered physode-containing cells (stippled) in the cortical region.



Figs 6-8. Figs 6-7. *Jolyna furcata*. Fig. 6. Cross-section of blade showing dark cells containing physodes. Fig. 7. Portion of a blade cross-section with plurilocular organs. Fig. 8. *J. laminarioides*. Longitudinal-section of blade (*08092001-03-18*, MICH). Scale bars: 100 µm in Figs 6 & 7; 300 µm in Fig. 8.

Additional collections: type locality: 18.ix.2000, *leg. M. Wynne 18092000-18-01* (BM, MICH, ON). Western side of Wadi Zeid (= Hoon's Bay) (16.94497° N, 54.80402° E), east of Mirbat, Dhofar, Sultanate of Oman: 17.ix.2001, *leg. M. Wynne 17092001-12-01* (BM, MICH, ON). Wadi Forh (= Lennon's Bay) (16.95833)° N, 54.73166° E), 6 km east of Mirbat, Dhofar: 02.viii.1985, *leg. T. Wrathall Ref. 2B1*, 1-3 m. subtidal, moderately exposed (MICH).

DISCUSSION

Jolyna laminarioides and *J. furcata* can be distinguished on a number of morphological and ecological characteristics, which have been summarized in Tab. 1. Thalli of *J. furcata* are usually only 25-35 cm long and seldom exceed 1.0 cm in width, but thalli of *J. laminarioides*, as the epithet suggests, have a kelplike appearance, often 1-2 m in length and 3-4 cm in breadth. It is only at the upper edges of their vertical extent in the littoral zone do thalli of *J. laminarioides* become of smaller stature, but even then they are consistently much thicker than the blades of *J. furcata*. Bifurcation of thalli (once, twice, or sometimes up to three times) in *J. furcata* is commonly observed, whereas thalli of *J. laminarioides* are typically simple. Occasionally thalli of *J. laminarioides* become marginally branched or proliferous distally; this appears to be blade regeneration after injury.

Cross-sections of the blades of *Jolyna furcata* reveal a similar composition to that of *J. laminarioides* in that small pigmented surface cells lead into larger subcortical cells, and then to inner larger and colorless medullary cells, with an innermost zone of elongate medullary cells. The medulla in *J. laminarioides* is simply much broader, filled with a complex of variously shaped cells, as depicted in Fig. 8 (Omani material) and by Guimarães *et al.* (1986). An easily detected visible distinction in cross-sections of blades is the abundant presence of physode-filled cells in *J. furcata*. Such physode-containing cells have not been reported in *J. laminarioides*. Another visible difference is the absence in *J. furcata* of hair-tufts, arising from depressions, as occur in *J. laminarioides* (Wynne & Banaimoon, 1990).

The occurrence of physode-filled cells has been reported for various brown algae. These cells have been called 'ascocysts' (Fritsch, 1945; Kogame &

Table 1

	Jolyna furcata	*Jolyna laminarioides*
habit	simple or divided, proliferous at base when older	simple, may become proliferous when injured
thallus length	20-45 cm	20-150 cm
thallus width	0.6-1.3 cm	3-4 cm
thallus thickness	280-340 µm	850-940 µm
physode-filled cells	present	absent
hair-tufts	absent	present
habitat	higher in littoral-supralittoral, more protected sites	lower in the littoral zone, very exposed sites

Yamagishi, 1997), 'paraphyses' (Wynne, 1969; Parsons, 1982), and 'club-shaped fucosan cells' (Christensen, 1980). In *Himantothallus grandifolius*, Wiencke & Clayton (1990) described the sori of unilocular sporangia to be interspered with two- to four-celled paraphyses filled with physodes. Hamel (1937) applied the term 'ascosyst' for the physode-filled cells in *Ascocyclus* and used the term 'pseudoparaphysis' for the enlarged physode-filled cells in some members of the Scytosiphonaceae.

Up to now in the Scytosiphonaceae these physode-filled cells were known to occur in the sori of plurilocular sporangia (or gametangia) (Wynne & Norris, 1976; Parsons, 1982). In his study of several species of *Colpomenia* in New Zealand, Parsons (1982) observed that the first indication of sorus formation is the appearance of small cells densely packed with pigments and golden-brown physodes and that these cells are destined to develop into the sterile, 1-3 cells paraphyses scattered among the plurilocular organs. The present observations of *Jolyna furcata* indicate that the cells with physodes are initiated at the blade surface but later extend inwardly and become sunken enlarged medullary cells. Such a changing location of physode-containing cells has not been reported in other members of the Scytosiphonaceae. Wynne (1969) distinguished a new species of *Scytosiphon* (*S. dotyi*) from the more common *S. lomentaria* (Lyngb.) Link by, among a number of traits, the lack of fucosan-filled paraphyses in the former species and their presence in the latter species. This was confirmed for British populations of this pair of species (Fletcher, 1987). Thus, there is a prededent for using the presence of absence of physode-containing cells in distinguishing species within genera of this family.

Schoenwaelder (2002) recently reviewed the occurrence and purported physiological and ecological functions of physodes in the brown algae. Phlorotannins, or phenolic compounds, contained in physodes are thought to protect brown algae from biological and possibly physical stresses in the environment (Clayton, 1988). There is some evidence that they serve as herbivore deterrents (Steinberg, 1985; Targett & Arnold, 1998). Another purported function of physodes is protection against excessive irradiation (Kaur & Vijayaraghavan, 1992), UV radiation, in particular (Pavia *et al.*, 1997). Ragan & Jensen (1978) demonstrated a positive correlation between the amount of physodes in tissues of *Ascophyllum nodosum* (L.) Le Jol. with increased levels of irradiance and desiccation. The fact that three of the four collections of *Jolyna furcata* were made in the supralittoral zone strongly suggests that there may be a similar role played by the physode-filled cells in their tissue.

Jolyna laminarioides is now recognized to be a dominant brown alga in the littoral zone of the rocky coastline from the Hadramout coast of Yemen in the west, the southern coast of Oman, and Pakistan in the east (Wynne & Banaimoon, 1990; Ormond & Banaimoon, 1994; Hameed & Ahmed, 1999). This geographical range is correlated with the seasonal monsoon impacting this region. The peak growth season of the *J. laminarioides* in southern Oman occurs at the time the waves are buffeting the exposed sites. At the present time *Jolyna furcata* appears to be a much less common species, known so far only from Dhofar, Oman, and restricted to more protected habitats than the surf-loving *J. laminarioides*. As more intensive collecting is carried out throughout the northern Arabian Sea, it will be interesting to learn if the new species has a wider distribution than is currently recognized.

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