compared to the unfamiliar individual (Wilcoxon matched pairs signed rank test, $T = 485$, $N = 35$; $P < 0.001$; Figure 2). The test fish spent only a few seconds (<0.5% of the total time) in the non-preference zone. The result of the present study shows that climbing perch possesses the ability to recognize a familiar shoal mate even in isolation and exhibit differential response to it and to an unfamiliar conspecific.

As a shoal-living species, the ability for individual recognition in climbing perch helps to reduce aggression among shoal mates. For instance during the initial days of stocking, climbing perches exhibited aggressive behaviour by nipping each other with the mouth; but by day 3, the aggressive displays reduced significantly and disappeared afterwards. It is possible that the observed reduction in aggression among group-housed climbing perches may be the result of the familiarity that develops among the members as a result of cohabitation.

Shoal choice and shoal cohesiveness is also related with the ability for individual recognition[9]. Recognition of shoal mates also helps to perform group manoeuvres more fruitfully, thus enhancing the benefit of shoal-living[11]. The study shows that the climbing perch prefers to spend more time with the shoal composed of familiar individuals rather than with that formed of unfamiliar conspecifics. However, the size of the shoal has an overriding influence on the preference and selection based on familiarity[10].

One of the advantages of shoal-living is said to be the efficiency of spreading information on food source rapidly among the members of the shoal[15]. Individual recognition and familiarity may further augment this effect. Assessment of the activities of shoal mates is crucial in the context of decision-making, whether to stay in the same shoal or to join another during encounter with other shoals. Certain fishes routinely change shoals and join other shoals composed of poor competitors[16]. As a species endowed with the ability to assess both the size of the shoal[10] and the capacity to identify shoal mates, the climbing perch seems to be a good model for studying cognitive abilities of fish.

1. Laland, K. N., Brown, C. and Krause, J., *Fish Fish.*, 2003, **4**, 199–202.
2. Brown, J. A. and Colgan, P. W., *Behav. Ecol. Sociobiol*., 1986, **19**, 373–379.
3. VanHarve, N. and Fitzgerald, G. J., *Biol. Behav*., 1988, **13**, 190–201.
4. Brown, G. E. and Smith, R. J. F., *J. Chem. Ecol*., 1994, **20**, 3051–3061.
5. Krause, J., Butlin, R. K., Peuhkuri, N. and Pritchard, V. L., *Biol. Rev*., 2000, **75**, 477–501.
6. Houde, A., *Sex, Colour and Mate Choice in Guppies*, Princeton University Press, Princeton, 1997.
7. Krause, J., Godin, J.-G. J. and Brown, D., *J. Fish. Biol*., 1996, **49**, 221–225.
8. Milinsky, M., Pfluger, D., Kulling, D. and Kettler, R., *Behav. Ecol. Sociobiol.*, 1990, **27**, 17–21.
9. Griffith, S. W., *Fish Fish.*, 2003, **4**, 256–268.
10. Binoy, V. V. and Thomas, K. J., *Curr. Sci*., 2004, **86**, 207–211.
11. Pitcher, T. J. and Parrish, J. J., *Behaviour of Teleost Fishes* (ed. Pitcher, T. J.), Chapman & Hall, London, 1993, pp. 363–427.
12. Ward, A. J. W., Axford, S. and Krause, J., *Proc. R. Soc. London, Ser. B*, 2003, **270**, 1157–1161.
13. Hoare, D. J. and Krause, J., *Fish Fish.*, 2003, **4**, 269–279.
14. Seppä, T., Laurila, A., Penkkuri, N., Piironen, J. and Lower, N., *Can. J. Fish. Aquat. Sci*., 2001, **58**, 1380–1385.
15. Swaney, W., Kendal, J., Capon, H., Brown, C. and Laland, K. N., *Anim. Behav*., 2001, **62**, 591–598.
16. Chivers, D. P., Brown, G. E. and Smith, R. J. F., *Can. J. Zool*., 1995, **73**, 955–960.

ACKNOWLEDGEMENTS. We thank DST, New Delhi for financial assistance, and Management and Principal of Christ College, Irinjalakuda for facilities. We are grateful to Moncey Vincent and P. V. Joshy for support during the study.

Received 21 March 2005; revised accepted 1 December 2005

V. V. BINOY
K. JOHN THOMAS*

Animal Behaviour and Wetland Research Laboratory,
Department of Zoology,
Christ College,
Irinjalakuda 680 125, India
**For correspondence.*
e-mail: jkurishinkal@rediffmail.com

Sexual anomaly in a marine red alga *Polysiphonia unguiformis* Boergesen

The red algae, majority of which are confined to coastal environments, play a pivotal role in the economy of many maritime states in the world. Their use, especially the fossil and coralline algae, as experimental tools and palaeoenvironmental indicators in unravelling the origin of the life on our planet is also well known. Genera like *Polysiphonia* with considerable species diversity, presence or absence of functional and nonfunctional reproductive organs on individual plants and the impact of environmental conditions on the evolution of such reproductive structures is a matter of curiosity among taxonomists.

Red algae (Rhodophyta) are unique in the plant kingdom in having non-motile sperms (spermatia) and a triphasic life cycle. In *Polysiphonia*, there are three phases in the life cycle – gametophytic (haploid plants), carposporophyte (diploid plants) and tetrasporophyte (diploid plants). There are two diploid phases alternating with a haploid phase (diplobiontic type). Tetrasporic and gametophytic plants (male and female) are morphologically similar (isomorphic), whereas carposporophyte is developed on female plant after fertilization[1,2].

The genus *Polysiphonia* first described by Greville[3] is a common red alga coming under the class Rhodophyceae, order Ceramiales, family Rhodomelaceae. Mostly it is attached to other plants or any other substrata. The plant body is small, polysiphonous, heterotrichous, branched and filamentous. The filament is attached by means of rhizoids or hapterae. Normally gametophytic plants (female and male) reproduce sexually by producing eggs (inside the carpogonia) and spermatia in the spermatangia[2]. Both the gametes fuse to form a diploid zygote. The zygote undergoes complicated post-fertilization changes and develops into a carposporophyte, which is in the form of a cystocarp. The carpospores produced inside the

cystocarp come out through the ostiole and germinate into an independent tetrasporophyte. Some of the pericentral cells in the tetrasporic thallus function as tetraspore mother cells and divide by meiosis and produce four haploid tetraspores. They are liberated outside and out of the four tetraspores, two develop into male plants and two into female plants[4,5]. Figure 1 *a* shows the life cycle of *Polysiphonia*. This pattern of life cycle is observed in all the species of *Polysiphonia*, including *Polysiphonia unguiformis*[1].

The present correspondence is on the sexual anomaly observed in *P. unguiformis* Boergesen[6,7] collected from the Dapoli coast of Maharashtra (17°45′N and 73°10′E) in October 2004 . During routine observations of collected specimens under microscope, we noticed that the plants produced tetraspores and spermatia in the same thallus, thereby skipping the intermediate stages of fully-grown male and female gametophytic plants. This is a rare phenomenon observed in algae. This can be either a sexual anomaly or a tendency towards progressive evolution from the primitive triphasic life cycle of a typical red alga to a diphasic life cycle in land plants (Figures 1 *b* and 2).

P. ureolata Rosenvinge is reported to have small, undivided sporangia (tetrasporangia) on plants with mature cystocarps, while Kylin also reported aborted sporangia on sexual plants. It is thus probable that the sporangia borne on sexual plants usually undergo no reduction and produce only haploid monospores[2].

The occasional occurrence of tetrasporangia on sexual plants of the haplobiontic Nemalionales warrants the supposition that this characteristic organ of floridae evolved prior to the establishment of the diplobiontic life cycle. There is also increasing reason to believe that the mere presence of tetrasporangia is no proof of the diploid character of the individual on which they occur. It seems probable that when an isomorphic alteration was first established by postponement of meiosis, each of the two phases still bore tetrasporangia, although reduction was associated only with the sporangia of one phase; it is possible that this phase for a time still possessed functional or functionless sex organs. Persistence of abortive sex organs on the diploid phase and monospore-producing sporangia on the haploid phase would be tokens of an ancestral condition and would mark a more primitive state than the sharp individualization of two phases that characterize many diplobiontic florideae[2].

In this connection, it is noteworthy that simultaneous presence of sex organs and sporangia is relatively more frequent in Ceramiaceae than in the more specialized families of Ceramiales.

Further culture studies in controlled conditions are required for elucidating the details.

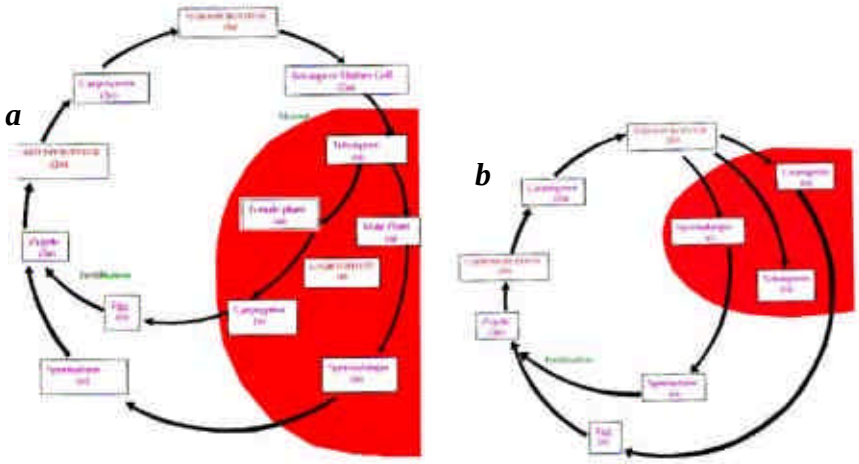

Figure 1. Normal life cycle (***a***) and anomalous life cycle (***b***) of *Polysiphonia unguiformis* Boergesen.

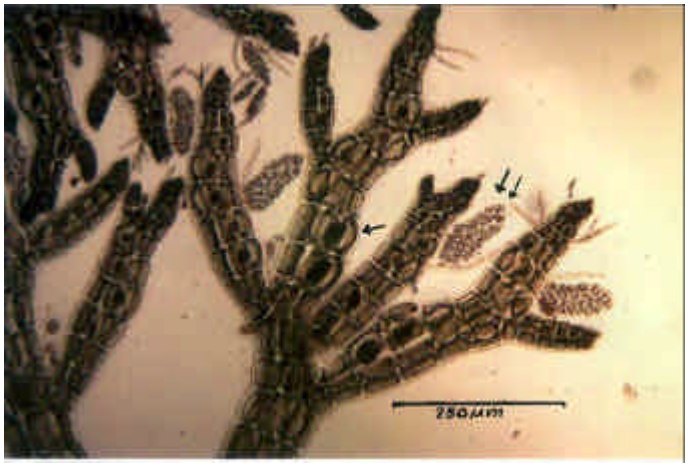

Figure 2. *P. unguiformis* Boergesen (→), Tetraspores; (⇉), Spermatangia.

1. Desikachary, T. V., Krishnamurthy, V. and Balakrishnan, M. S., *Rhodophyta, Vol. II, Part II B*, Madras Science Foundation, Chennai, 1998, p. 291.
2. Fritsch, F. E., *The Structure and Reproduction of the Algae, Vol. II*, Cambridge University Press, 1959, pp. 722–724.
3. Greville, R. K., *Scottish Cryptogamic Flora, Vol. 2*. Edinburg, 61–90 (1823), 91–120 (1824) (with text).
4. www.botany.hawaii.edu.
5. www.blackwell-synergy.com
6. Boergesen, *J. Indian Bot. Soc.*, 1937, **16**, 311–357.
7. Oza, M. R. and Zaidi, S. H. A., Revised checklist of Indian Marine Algae, CSMCRI, Bhavnagar, 2001.

ACKNOWLEDGEMENTS. We thank Dr M. Sanjappa, Director, Botanical Survey of India, Kolkata for providing facilities and financial support. We also thank Dr B. B. Chaugule for guidance.

Received 8 August 2005; accepted 28 November 2005

SONALI JADIYE
C. ANILKUMAR
P. S. N. RAO*

Botanical Survey of India,
Western Circle, 7, Koregoan Road,
Koregoan Park,
Pune 411 001, India
**For correspondence.*
e-mail: bsi_wcpune@yahoo.co.in