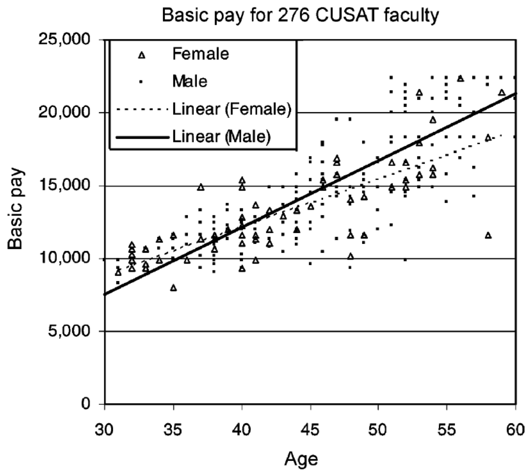

Figure 3. *X–Y* scatter diagram showing how the basic pay of the two gender groups cluster in different ways. Trend-lines were also computed, which reveal clearly that female faculty members under 40 years have a small financial advantage over their male counterparts.

To continue the analysis, the linear trend-lines can be described by the formulae:

BP (male) = –6255.47 + 459.07*(age),

BP (female) = –1169.99 + 332.22*(age).

The monthly financial advantage (or disadvantage) is then taken as being invested annually in a secure financial instrument which gives compound interest at a specified rate. The data above imply that on average, at age 30 years, females actually start with a Rs 1280 per month advantage, which is then neutralized by age 40 years. At the age of 60 years, a male earns approximately Rs 2525 more than his female counterpart, in terms of BP alone. If a financially astute female faculty member invests this differential as proposed above, then the investment of the difference in BP between a male and a female accumulates as net worth to the individual. Spread-sheet cash-flow calculations show (not included here), that in the medium term (i.e. when the projection is carried only to the age of 60 years, the current age of retirement), a male will never be able to recoup the pecuniary opportunity he has lost in the early part of his career, if the compound interest is more than 7%, just by investing only the differential in BP (note, allowances are ignored in this calculation). The post-retirement pensionary benefits which are a function of the last pay drawn at the time of retirement have not been factored in, and considering the current average life-expectancy, this could mean a substantial post-retirement income (fairly well comparable with an employee's entire earnings during his/her service period). Accounting for this, the bottom-line is, 'it pays to be male!'

Otherwise, whatever gender disparity there is, as long as female faculty join service at an early age, they have a long-term pecuniary advantage.

Concluding remarks

A new approach has been proposed to quantitatively explore issues like gender–wage gap. By working with a sample where men and women have nearly identical backgrounds, it is seen that between the ages of 30 and 40 years, women actually have a positive gender pay advantage and lose this only after 40 years of age. Qualitative evidence suggests that two reasons for men more than making up for this early disadvantage in later years is that women are likely to take time off to start families and become home-makers, and are also less likely to pursue and earn PhDs. This will translate into a glass ceiling of sorts, as current practices (UGC and AICTE norms) require a PhD for promotion to Reader and Professor grades.

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Reflections on the discovery of toxic species of marine micro-algae known to form harmful blooms

S. R. Bhat

Harmful algal blooms (HAB) are scientifically complex events challenging our ability to safeguard the health of the coastal ecosystems. As natural events, algal blooms do have beneficial effects on the marine environment, but their adverse impacts prominently discernible from the catastrophic loss of cultured and wild fish, and ill-effects on human health have created a daunting impression globally. HAB research, therefore, largely aims to achieve bloom prediction capability and mitigation of adverse impacts. In the interim, it looks for rapid bloom detection methods and effective transmission of safety alerts for human health and fish stocks under aquaculture.

Currently, HAB detection in the ocean regime relies mainly on costly cruises for sampling and microscopic identification of constituent bloom species. Identification to a species level and the time required to do so, are critical in issuing alerts or advisories primarily for fishing industries and public health. This underlines the importance of taxonomy and taxonomists.

Table 1. Number of species discovered and revised during different periods

Group (no. of spp)	Species discovered 19th century	20th century	2000–2004	No. of species revised and time period (years) between the first discovery and revision
Diatoms (13)	2	8	3	9 (2, 14, 15, 17, 21, 31, 38 and 96)
Dinoflagellates (70)				19
Dinophysiales (11)	9	2	–	2 (72 and 84)
Gonyaulacales (23)	1	22	–	8 (8, 14, 26, 32, 49, 49, 49 and 58)
Peridiniales (4)	–	3	1	1 (67)
Prorocentrales (13)	1	10	2	3 (15, 18 and 47)
Gymnodiniales (19)	1	10	8	5 (1, 7, 44, 52 and 65)
Haptophytes (9)	2	6	1	1 (1)
Raphidophytes (7)	–	7	–	3 (6, 20 and 28)
Total (99)	16	68	15	32

To check its relevance, the inputs on marine HAB species discovered so far, were examined. The taxonomic reference list of toxic algae[1] formed the major source (Tables 1 and 2). The emerging salient points do underpin the concerns about the progress of marine taxonomy vis-à-vis HAB species. This note hopes to invoke some attention in fostering the subject and boosting the morale of the research community associated with it.

The chronology of species discovered based on the IOC/UNESCO list and the tabulated inputs yielded the following salient points.

1. Between the years 1827 and 2004, 99 toxic species have been discovered, over 80% being during the 20th century and the following period.
2. During this time-span, 32 species underwent first revision after a lapse of variable period, in majority cases over three decades.
3. Almost 25% of the species has been revised during the second half of the 20th century.
4. Interestingly, among the 67 species, which still retain the basionymn, 28 have been discovered during the recent decade of 1994–2004.
5. Two dominant groups that largely make up the list of toxic species are dinoflagellates and diatoms, with 70 and 13 species respectively.
6. Amazingly all the 13 toxic species of diatoms discovered are pennate forms and none is centric.
7. Researchers associated with the discovery of the listed species are only a few, there being no appreciable change in their numbers from the 19th century.
8. Among the 99 toxic species, nine have resulted from the application of molecular/DNA analysis/probes and the rest identified following the classical/traditional taxonomy.
9. According to the list, diatom *Pseudo-nitzschia turgidula* was the first toxic species that resulted from the application of the molecular technique in 1997, such as whole-cell DNA probe and immunochemical assay. In the following years, a handful more taxa under the genus *Gambierdiscus*, *Gyrodinium*, *Dinophysis*, *Chattonella*, *Karenia* and *Karlodinium* were identified using similar methods.

The 18th century and the subsequent periods have been witnessing instances of HABs. George Vancouver's episode during British Columbia expedition in 1793 is the most widely known and cited. Early records partially based on native lore, do indicate that the toxic bloom phenomenon was recurrent along the European and American coasts for hundreds of years. One does find frequent mention of diatom *Pseudo-nitzschia* as toxic bloom former. A dense bloom of this species in the Skagerrak waters was reported[2] as early as 1912, but none of these caught the attention of the authorities until the eastern Prince Edward Island (Canada) episode of 1987. The island region was badly hit by the bloom of this diatom, with a few deaths and over hundred people reported sick after consuming mussels from the region. The mussels that had fed on *Pseudo-nitzschia* (known at that time as *Nitzschia pungens*) were found domoic acid (DA)-contaminated[3]. Now we know that at least 13 species of marine diatoms are toxic, including nine *Pseudo-nitzschia* producing DA, a rare and naturally occurring amino acid, which is toxic to marine mammals, seabirds and human beings.

The examples cited above illustrate that the bloom aspect did not draw enough research attention. The fact that only 16 species were discovered during the 19th century corroborates this view. However, the number shot up by 68 during the 20th century, and another 14 species were added in a short span of five years between 2000 and 2004. In brief, observations on HABs and taxonomic investigations picked up from the later part of the 20th century.

It is hard to believe that the marine regime, habitat to an estimated 50,000 diatom species (including 10–12 thousands already known), has so far revealed only 13 toxic species. It is further puzzling that all these are exclusively pennate forms. We know that centric diatoms are generally planktonic and pennate ones are mostly benthic. However, it is difficult to comprehend as to why planktonic diatoms are devoid of toxic species? It is for the taxonomists to throw light on these peculiarities. Concerted taxonomic efforts and application of modern techniques for closer examination and re-examination of species are bound to compel nature to reveal her secrets.

Revision of almost 25% of the IOC web-listed toxic species has taken more than three decades, and in some cases almost a century. For instance, diatoms *Nitzschia fraudulenta* P. T. Cleve 1897 and *Nitzschia pungens* Grunow ex P. T. Cleve 1897 were revised to *Pseudo-nitschia fraudulenta* and *Pseudo-nitschia pungens* respectively, by Hasle in 1993. Similarly, the dinoflagellate species *Phalacroma rapa* Stein 1883 was revised to *Dinophysis rapa* by Balech in 1967. There could be many reasons for such a lull and missed observations (?), but one major reason was the availability of limited facilities. One can imagine the problems and frustrations faced by taxo-

Table 2. Toxic species discovered during the recent decade 1994–2004

Year and species discovered	Group	First description by
1994		
Alexandrium tamiyavanichii	Dinoflagellate	Balech, E.
Ostreopsis mascarenesis	Dinoflagellate	Quod, J. P.
Prorocentrum arenarium	Dinoflagellate	Faust, M. A.
Chattonella globosa	Raphidophyte	Hara, Y. *et al.*
C. verruculosa	Raphidophyte	Hara, Y. *et al.*
1995		
Heterocapsa circularisquama	Dinoflagellate	Horiguchi, T.
Gyrodinium corsicum	Dinoflagellate	Paulmier, G. *et al.*
1996		
Pfiesteria piscicida	Dinoflagellate	Steidinger, K. A. *et al.*
Amphidinium operculatum var *gibbosum*	Dinoflagellate	Maranda, L. and Shimizu, Y.
1998		
Gambierdiscus yasumotoi	Dinoflagellate	Holmes, M. J.
Prorocentrum faustiae	Dinoflagellate	Morton, S. L.
1999		
Gambierdiscus pacificus	Dinoflagellate	Chinain, M. *et al.*
G. polynesiensis	Dinoflagellate	Chinain, M. *et al.*
G. australes	Dinoflagellate	Chinain, M. *et al.*
2000		
Nitzschia navis-varingica	Diatom	Lundholm, N. and Moestrup, Θ
Prorocentrum borbonicum	Dinoflagellate	Ten-Hage, *et al.*
Karena digitata	Dinoflagellate	Chang, F. H. *et al.*
2001		
Pfiesteria shumwayae	Dinoflagellate	Glasgow, H. B. *et al.*
Prymnesium faveolatum	Haptophyte	Fresnel, J. *et al.*
2002		
Pseudo-nitzschia galaxiae	Diatom	Lundholm, N. *et al.*
Prorocentrum arabianum	Dinoflagellate	Morton, S. L. *et al.*
2003		
Pseudo-nitzschia calliantha	Diatom	Lundholm, N. *et al.*
Karenia bicuneiformis	Dinoflagellate	Botes, L. *et al.*
K. cristata	Dinoflagellate	Botes, L. *et al.*
2004		
Karenia concordia	Dinoflagellate	Chang, N. *et* Ryan
K. papilionacea	Dinoflagellate	Haywood, A. J. *et al.*
K. selliformis	Dinoflagellate	Haywood, A. J. *et al.*
K. umbella	Dinoflagellate	de Salas, M. F. *et al.*

Dinoflagellates, 22 spp; Diatoms, 3 spp; Raphidophytes, 2 spp, and Haptophytes, 1 sp.

nomists, who relentlessly continued to build upon the taxonomy foundation laid by Carl Linnaeus, despite several constraints.

Classical taxonomy during the past few decades has progressed through different approaches and now the advent of molecular technique is one big step added to facilitate accurate identification of species. Since classical taxonomy is predominantly morphology-based, the subtle characteristics of certain complex species makes the identification tedious and at times inaccurate. We have good examples of the extensively studied dinoflagellate and diatom genus, *Alexandrium and Pseudo-nitzschia* respectively. In dinoflagellates, morphology and cytology are used as valid criteria in subgrouping them, as the presence or absence of thecal plates, their arrangement and number, cell shape, etc. are key characteristics. However, for the detection of inter and intra species variability, molecular probing and genomic sequencing prove critical. These methods, though not yet a foolproof guide in species identification, have given greater impetus to taxonomic investigations and in refining the already gained knowledge. The added impetus would come from the induction of professional personnel, both for full time taxonomic work and in effectively linking it to other aspects of plant science.

Marine micro-algal taxonomy is largely in the initial phase, and transition to a more sophisticated understanding is in progress. Its advancement lies in the hands of generation that would carry forward works of pioneers such as F. J. R. Taylor, T. V. Desikachary, M. O. P. Iyengar, Enrique Balech (see personal news on Enrique Balech Capdeville in this issue, p. 1488) and several others.

1. Moestrup, O. (ed.), *IOC Taxonomic Reference List of Toxic Algae*, Intergovernmental Oceanographic Commission of UNESCO, 2004; ioc.unesco.org.hab/data.htm
2. Hasle, G. R. and Syvertsen, E. E., In *Identifying Marine Diatoms and Dinoflagellates* (ed. Tomas, C. R.), Academic Press, CA, 1996, pp. 5–385.
3. Bates, S. S. *et al.*, *Can. J. Fish Aquat. Sci.*, 1989, **46**, 1203–1215.

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