Assoc. Prof. Vyara Petrova-Karadzhova: a life dedicated to the sea

In memory of the 75th anniversary of her birth

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This year, on June 7th, Vyara Petrova, the founder of marine phytoplanktonology in Bulgaria, would have become 75 years old. Her death on 28th April 2002 was unexpected to all: relatives, friends and colleagues. Until her last days she was so active, efficient, and full of ideas and working plans.

It was difficult to believe that Vyara was not here anymore and even more difficult to accept her loss. Her place among colleagues and friends is now empty forever, but her lifework remains. More than one generation of biologists connect her name with that of her favourite Institute with Aquarium in the town of Varna, in which she spent 42 years, all her working life, the Institute, where she laid down and consolidated the foundations of phytoplanktonology of the Black Sea in Bulgaria.

Vyara Petrova practically left no archives: two folders of applications, some of her correspondence and a short CV written for her participation in a competition for a Associate Professor. So out of this scanty information, aided by the memories of fellow-students, friends and colleagues she used to work with (Prof. DSc Venelin Beshovski, Assoc. Prof. Dr. Snezhana Moncheva, Dr. Iliya Shtirkov) and from my personal impressions I would try to reconstruct her lifework and reveal her spiritually rich personality.

Vyara Petrova was born on 7th July 1930, in Sofia, where she grew up. Her father had a fine mechanics workshop, which after 1944, along with all its equipments, was merged with the Voroshilov Mechanical Works, where he was left to work until his retirement. Her mother had graduated from a dressmakers' school in the town of Rouse.

Vyara Petrova finished junior high education in the Antim I Basic School. In the academic year 1944–1945 she entered the 2nd Sofia High School for Girls and in 1948 graduated with flying colours (5.84). In the same year she enrolled as a student at the Physics and Mathematics Faculty of Sofia University in the specialty Natural Sciences, which in 1951 was transformed into the Faculty of Biology, Geology and Geography.

The radiantly beautiful girl soon attracted the attention of her university professors with her thirst for knowledge, diligence and industriousness. Years later, Dimo Bozhkov, then Assistant Professor in Zoology of Invertebrates, in a letter to V. Petrova (of 17th March 1958) written on the occasion of an article published by her on Dinoflagellata planktons at the Buglarian Black Sea Coast, noted down that she could take pride in her work, and said further, "I am well aware of your precision, abilities and industriousness since your student years."

During her university years V. Petrova showed interest in invertebrates and took an active part in the student scientific circle at the Zoology of the Invertebrates Chair. Under the guidance of Assoc. Prof. Georgi Kozarov she studied the development of the parasitic worm *Fasciola hepatica* in its intermediate host, the snail *Limnea truncatula*.

Vyara Petrova completed her higher education in biology in 1952, again with excellent marks (4.61 on the five-point scale). Immediately upon graduation, V. Petrova and her fellow-student Boris Rousev (who subsequently grew into a prominent hydrobiologist and zoobenthologist) were invited by Prof. Alexander Vulkanov to work at the Marine Biology Station with Aquarium in Varna, where he was Director. V. Petrova and B. Rousev accepted and the same year went to Varna. That year marked the outset of their comradely cooperation of long standing and good friendship.

Thus, in October 1952 V. Petrova commenced work as Assistant Professor at the Marine Biology Station with Aquarium, Varna, at the Kliment Ohridski Sofia State University. In 1954, after a merger with the Institute of Fishing and Fishery, the Marine Biology Station was transformed into the Research Institute of Fishery and V. Petrova was reappointed as a Research Associate at the Hydrobiology Department, where she proceeded to work until her retirement on 31st December 1990.

Prof. A. Vulkanov directed V. Petrova's attention towards scientific research in the field of marine phytoplanktonology. She had the great chance to work under the direct guidance of that highly knowledgeable hydrobiologist, widely known in Bulgaria and abroad, a favourite professor of many students. Prof. A. Vulkanov knew V. Petrova since her student years and had already appreciated her keen and analytical mind and thirst for work. V. Petrova started work with great enthusiasm, under the strong spell of the well-known "Vulkanov" fervour. Her direct and frequent communication with the Professor made of her an excellent young scholar. V. Petrova deeply respected and loved her Professor and was forever grateful to him. Under his strict looks and wilful personality she had perceived unusual sensitivity and a kind hearth.

Vyara Petrova was lucky enough to be included in the group of hydrobiologists under Prof. A. Vulkanov, comprising the zoobenthologists Veska Kuneva-Abadzhieva and Prof. Tenyo Marinov, and zooplanktonologist Ivan Dimov, who were already engaged in intensive research of the Black Sea. Her colleagues from the Institute quickly accepted Vyara Petrova. She had prevailed with her characteristic precision and responsibility and with her straightforward character. Prof. V. Beshovski wrote about V. Petrova, "Vyara was a radiant person, with an open and straightforward character. She freely expressed her joy and approval of the work of her colleagues, and criticised the shortcomings in the research work of the specialists and in their comradely relations. Her spontaneous criticism was not much to the liking of some of her colleagues, but thanks to her straightforwardness and independent character, Vyara had managed to convince the people at the Institute to abide by her opinion as a scholar, colleague and simply as human being."

Since the end of 1952, V. Petrova had engaged into systematic research of the qualitative and quantitative composition of the phytoplankton and its seasonal and annual dynamics along the Bulgarian Black Sea Coast. Initially, she studied month by month the species composition and seasonal dynamics of the phytoplankton in lake Varna and Varna Bay. In 1954 she extended her studies to the seasonal dynamics and annual changes of the phytoplankton in the open sea, in front of the Bulgarian Black Sea Coast and in other regions of the northwestern part of the sea.

The first difficulty encountered by V. Petrova was the lack of any literature on algae. She was in dire need of keys and floras and undertook to enrich the library of the Institute with the requisite literature: a formidable task in those years, now hardly believed and understood by the young colleagues. With typical persistence she managed to provide books with the help of colleagues from the former USSR (the Ukraine and Russia), Romania and Czechoslovakia (Alexander Ivanov, Hilarius Skolka, Maria Celan, J. Komarek, Anastasya P. Proshkina-Lavrenko, Tatyana Popova, etc.), of Prof. Boris Kitanov, her fellow-student Prof. Dr. Dimitur Vodenicharov, etc., by ordering them at the Foreign Literature Book Shop in Sofia, from the international books exchange at the National Library in Sofia (where a book was available for only one month and without any right to be taken out of the library), by photocopying, etc.

Another stumbling stone for V. Petrova was sea-sickness. Since 1954 she had begun her regular participation in the continuous Black Sea expeditions organized by the Institute. She loved the sea and her work very much and bravely "fought" the sea-sickness, gradually managing to overcome it. In her letter to H. Skolka (24th August 1959) V. Petrova wrote proudly, "I seemed to have found my sea legs and do not suffer badly from sea-sickness now." She also braved helicopter flights so as to establish the scale of the mass "bloom" of waters across the Bulgarian aquatory.

The "bloom" of the poisonous *Prymnesium parvum* Carter in 1959, unusual for the Bulgarian coastal lakes in the Varna district, directed V. Petrova's attention to studying the toxic phytoplankton: an problem closely related to fish farming.

In support of the rational use of big coastal lakes for fish farming, V. Petrova started to investigate their phytoplankton (1961–1970): the seasonal and annual dynamics of the qualitative and quantitative composition of plankton algae in them as an indicator of their primary production. She had to assess the productive properties of the different lakes. Thus V. Petrova took part in the work on the practically important issue of increasing the fish output in those lakes.

Vyara Petrova (second from the left) with her colleagues in occasion of the 70th birthday of Prof. D. Vodenicharov, 1999

In 1963, in connection with the use of macrophytes from Bulgarian coastal waters and the programme task of the Institute to investigate new raw materials for the national economy, V. Petrova commenced the first researches into assessing the resources of *Cystoseira barbata* in the region of Sozopol, and in the period 1966–1969 the investigation extended to the entire Bulgarian coastline. The Institute was entrusted with that task after the decision for a processing works for *Cystoseira* and *Phyllophora* to be built by Balkantrans State Enterprise for the production of alginic acid, sodium alginate, fodder meal, and agaroids. As an adviser to Bulet Enterprise, V. Petrova took part in elucidating the possibilities for the construction of a fodder mix works, with a workshop for algae processing. The issue of reproduction of *Cystoseira* was also put forward. V. Petrova embraced the idea of Dr. Iliya Shterev of using concrete blocks as an artificial substrate, on which to record the foulings. The entire Underwater Resarch Laboratory of the Institute worked under V. Petrova. Two hundred concrete blocks measuring 50/50/25 cm were made and placed in the coastal waters by profiles at the depth of 3 m, 6 m and 9 m, their locations fixed geodetically by benchmarks. Unfortunately, the merging of the Laboratory with the newly created Institute of Oceanology with the Bulgarian Academy of Sciences brought that research to an end.

Sea grass, with its rich chemical composition and potential for use in livestock breeding, did not escape the attention of V. Petrova. In the period 1977–1978, with the help of scuba equipment, she carried out large-scale studies into the resources of two *Zostera* species.

Within the framework of the expeditions V. Petrova visited the Black Sea biological stations and institutes in Constanța, Odessa, Sevastopol, Yalta and Kerch and became personally acquainted with some colleagues, with whom she had maintained for many years active correspondence and contacts: A. I. Ivanov – Biological Station of the Academy of Sciences of the Ukrainian Soviet Socialist Republic, Odessa; Evgeniya V. Belogorskaya and Tamara M. Kondratyeva – Biological Station of the Academy of Sciences of the USSR Sevastopol; H. Skolka – Constanța Black Sea Station, M. Celan – Marine Zoology Station, Agigea-Constanta. She also maintained correspondence with L. Alexeevna and L. Lanskaya from the Sevastopol Station; G. K. Pitsyk from Azcherniro-Kerch; Vera G. Stroikina from the Biological Station of ASUSSR, Komsomolskaya on the Volga, Kuibyshev district; Alexandra Shmeleva from Yalta; Ivan Kazilov from the Crimea, Katzivelli, ASUSSR; N. Aslanova from Moscow; Mihai Baresco and N. Budeanu from Bucharest; Alexandra P. Proshkina-Lavrenko from the Institute of Botany of ASUSSR, Saint Petersburg, etc. In their letters to V. Petrova some of them showed interest in the collection of samples and the methods for their quantitative processing, others focused their attention on the methods of work with an inverted mi-

croscope, on the mass-developing species, the 24-hour and seasonal changes of the phytoplankton, its numbers and biomass. They shared with her their results, asked for her opinion and advice about their researches, including for determining or specification of plankton algae species. V. Petrova had quickly established herself as a good phytoplantologist.

The letters of her closest colleagues and friends, A. Ivanov and H. Skolka, express respect for her as a specialist and human person. In his letter of May 9th 1957 H. Skolka wrote, "…I must admit that you have helped me greatly in my work. Your advice was good and I shall work as you have advised me."

Vyara Petrova was greatly valued and respected as a specialist and loved as a friend by her Bulgarian colleagues. She maintained close friendship with Prof. Dr. B. Rousev, Assoc. Prof. I. Dimov and Prof. Dr. Vodenicharov, and subsequently with Prof. DSc. Temniskova, as well as good comradely relations with Prof. V. Beshovski, Prof. Veselin Naidenov, Assoc. Prof. Angel Angelov, Assoc. Prof. Margarita Mihailova, and Assoc. Prof . Stefka Dimitrova. My friendship with Vyara Petrova was born during our joint work on benthic diatoms from the Bulgarian Black Sea shelf. She was a person who greatly valued friendship, hated hypocrisy and was a true friend. It was a pleasure to work with her: a person of dedication, accurate and precise, with a keen feeling of responsibility. She defended persistently her own opinion, but also had the gift to listen to the other person and agree with the opinion of others. Vyara Petrova was a person of great erudition. She was well familiar with the Bulgarian and foreign classic literature, kept in pace with the modern literary writings, loved symphony and opera music and the theatre. Conversations with her were interesting, meaningful and absorbing. Vyara Petrova was a cheerful and natural person, who loved a joke. Her ability to write in the satirical line occasionally showed in her letters to some closer collages (for instance, to V. Naidenov, on December 3rd 1958).

Vyara Petrova was helpful and correct, always ready to lend a hand or do a favour: lend books, send diatom and dinophyte samples for exercises in plant systematics and hydrobiology to Sofia University. She was attentive to the younger biologists and especially to students who were on probation at the Institute. She was an excellent professor, willing and able to communicate knowledge. One of her former students, Maria Tsolova, in her letter to V. Petrova of January 1959 wrote: "While on probation, I have learned so many valuable things from you that I always think of you with gratitude."

The first and most prosperous student of V. Petrova was Dr. Snezhana Moncheva, presently Deputy Director of the Institute of Oceanology, BAS. She continued the good tradition of studying the quantitative and qualitative composition and dynamics of the phytoplankton and the anthropogenic impact on it. Along with this, she expanded and developed her work in various avenues of phytoplankltonology and is now Bulgaria's leading marine phytoplankltonologist with wide-ranging international activities.

Vyara Petrova specialized for a brief span at the former GDR and in Israel. The meetings for exchange of experience at the Ukrainian, Russian and Romanian marine research institutes proved particularly useful to her.

After 15 years of scientific work as a Research Associate, in 1968 V. Petrova gained the academic degree of Senior Research Associate in Marine Planktonology at the Hydrobiology Department of the Research Institute of Fisheries and Oceanography.

Vyara Petrova was invited to international conferences and congresses to read her papers, where, according to Prof. A. Vulkanov, "she presented befittingly the achievements of the Bulgarian hydrobiological science." She took part in the congresses of the International Commission for Research of the Mediterranean Sea (19th Congress in Monaco – October 1964; 20th Congress in Bucharest – October 1966; 30th Jubilee Congress in 1987; 31st Congress in Athens in 1988, in Palma de Majorca in 1990, etc.); 10th International Conference on the Danube – 1966; World Congress on Botany in Saint Petersburg – July 1975; Black Sea Symposium on the Ecological Problems and Economic Prospects in Istanbul – September 1991. In Bulgaria V. Petrova read eight subsequently published papers at jubilee and practical conferences: the 50th Anniversary of the Bulgarian Botanical Society – Sofia 1975; Scientific and Practical Conference on the State of Research, Rational Management and Protection of Natural Resources in Varna Region – Varna 1983; 1st National Conference on the Problems of Biological Monitoring – Plovdiv, October 1987; Symposium on Radiation Injuries and Radiation Research – Sofia, December 1987, etc.

As a specialist with academic degree, V. Petrova reviewed various scholarly works for the scientific coun-

cils which determined the conferring of scientific titles and degrees, drafted reports for the Medical and Biological Committee of the Higher Accreditation Commission, and engaged in reviewing of diploma works at various universities and higher schools (according to her personal notes, she had delivered a total of 60 and more reviews).

Since January 15th 1959, V. Petrova had held membership at the Bulgarian Botanical Society and since May 29th 1959 had been member of the Union of Research Workers in Bulgaria. Since 1960 she was a member of the International Commission for Research of the Mediterranean Sea.

After her retirement V. Petrova was reading lectures on Macrophytobenthos (1994–2000) and Ecology (2000–2002) at the N. Y. Vaptsarov Higher Naval School, Civil Marine Faculty, the chairs of Marine Ecology and Navigation: Ship Machienry and Mechanisms. V. Petrova also taught Botany (2000–2001) at the Technical University of Varna, Faculty of Marine Sciences and Ecology, Ecology and Environment Conservation Chair.

The scientific works of V. Petrova were written in the field of marine phytoplankltonology and represent a valuable contribution not only to the Bulgarian but also to world oceanography. The author manifested in them her erudition, knowledgeability and precision.

Vyara Petrova dedicated over 35 years of her life to the studies of phytoplankton in the Bulgarian aquatory of the Black Sea, in other regions of the northwestern part of the sea and the Bulgarian coastal lakes. She marked the start of systematic and thorough research into the qualitative composition of the phytoplankton and was the first to study its quantitative distribution, its seasonal and annual dynamics. She established the major objective laws of its development, depending on the abiotic and biotic factors of the environment, and expressed mathematically some of these dependencies. V. Petrova was also the first to elucidate the trophic relations in the Bulgarian Black Sea aquatory. She discovered the objective laws in the throphic relations between the various hydrobionts and to what degree they reflected on the spawns of industrial fish species.

The scientific works of V. Petrova were repeatedly cited by Bulgarian scholars (Lyudii Ivanov, Stafan Stoyanov, Petar Kolarov, K. Alexandrova, A. Vulkanov, etc.). Her publications were well known outside Bulgaria and frequently cited by Russian, Ukrainian and Romanian researchers of the Black Sea, working in the domain of phytoplankltonology and productivity of this sea basin (phytoplankltonologists A. Ivanov, G. Pitsyk, oceanologists S. Boresco, H. Skolka, N. Bodeanu, the French planktonologist Tregubov, etc.).

The scientific publications of V. Petrova in Bulgarian and foreign journals and proceedings from various international conferences and congresses total 55.

Her contributions were of scientific and applied nature. Thematically they could be grouped as follows:

I. *Contributions to the phytoplankton in the Bulgarian aquatory and other regions in the northwestern part of the Black Sea* [1-14, 18, 19, 21, 23, 42-44, 47, 52]

The first contribution of V. Petrova to the species composition of phytoplankton from the Bulgarian Black Sea Coast on the basis of her own materials and the planktonological collection from 1932 to 1951 inclusive, placed at her disposal by Prof. A. Vulkanov, was a thorough study of the *Dinophyta* (45 taxa were identified, of which one genus and 23 species were new for the Bulgarian Black Sea Coast) and of the qualitative composition and quantitative distribution of the phytoplankton in Varna Bay (111 taxa of *Bacillariophyta*, *Dinophyta*, *Silcicoflagellales*, *Chlorophyta*, and *Cyanophyta*, of which 69 taxa new for the Bulgarian Black Sea Coast) [1, 4].

The systematic research of long standing carried out by V. Petrova in the period 1954–1970 resulted in a string of publications contributing to the studies into the phytoplankton of the Black Sea at the Bulgarian coastline, its species composition, quantity, biomass, seasonal and annual dynamics.

Vyara Petrova established that the species composition of the phytoplankton in the open areas in front of the Bulgarian coastline, up to 30–40 miles off the coast, was composed of over 170 algae taxa of *Bacillariophyta*, *Pyrrophyta* (*Dinophyta*), *Chrysomonadineae*, *Silicoflagellales*, *Coccoilithohophorales*, *Euglenophyta*, *Chlorophyta*, *Pterospermales*, and *Xanthophyta*. Of these, there were 110 taxa new for Bulgaria and seven taxa new for the Black Sea.

Credit goes to V. Petrova for the thorough and detailed study of the taxonomic composition of the Bulgarian Black Sea phytoplankton (over 200 seaweed taxa). That composition was supplemented by S. Moncheva and the subsequently presented by

V. Petrov and S. Moncheva general list of the species composition of the phytoplankton in front of the Bulgarian coastline comprised 97 genera, represented by 225 species and 10 varieties and forms [61].

Vyara Petrova outlined two zones in the spatial distribution of phytoplankton in the Bulgarian aquatory: coastal and open-sea. The quantity of phytoplankton in the first zone exceeded by many times that in the second zone. Vertical distribution of the phytoplankton in the open-sea zone usually reached 50–75 m, seldom a depth of 100 m, with marked concentration above the thermocline, and in the coastal zone it reached the seafloor.

Another contribution was the established seasonal dynamics on the basis of which V. Petrova outlined the perennial dynamics of phytoplankton in the Black Sea, in front of the Bulgarian coastline. The average annual biomass for the period 1954–1972 was 1.7 g/m^3 and it characterized the Bulgarian aquatory of the Black Sea as rich in phytoplankton. Seasonally, for the same period the average biomass of phytoplankton in winter was 1.6 g/m^3, which was considered relatively abundant, with the most abundant season in spring 2.5 g/m^3, 1.1 g/m^3 in summer, and 1.2 g/m^3 in autumn.

Summarising the results of her phytoplankton studies, V. Petrova drew several inferences concerning the objective laws to which the plankton dynamics was subjected and rendered them in mathematical formulae.

Vyara Petrova established cyclic recurrence of the abundance and impoverishment of the phytoplankton at sea in front of the Bulgarian coastline in periods of 5, 10 and 15 years (1956–1960; 1961–1965; 1966–1970), determined by the cyclic recurrence of solar activity and the seasonal and annual changes in environmental factors (temperature, salinity and content of biogenic salts in seawater). Thus, thanks to prolonged observations and the vast number of data about the phytoplankton, its seasonal and annual dynamics, V. Petrova proved the cyclic recurrence of its changes related to solar activity. She reported that novel to science fact before the International Commission for Research of the Mediterranean Sea in Palma de Majorca in 1990.

Vyara Petrova analysed the correlation of the phytoplankton and zooplankton biomass and expressed it in a linear function equation. This was a very important dependence. The phytoplankton created conditions for the development and growth of zooplankton and the subsequent links in the food chain. She proved that to increase the zooplankton by 1 mg/m^3, the phytoplankton should be increased 50 times (by 50 mg/m^3).

Vyara Petrova analysed the correlation of abiotic factors (temperature and biogenic substances) and algal biomass, establishing that the correlation points are subjected to the linear function equation $y = a + bx$. She found out a negative correlation in winter between water temperature and phytoplankton biomass, and positive correlation in spring and summer: that was why warm winters and cold springs and summers were unfavourable for the abundant development of phytoplankton. V. Petrova complemented the scanty existing data on the 24-hour changes of the phytoplankton numbers in the Black Sea. She established certain dependence between the quantitative development of phytoplankton in the different hours within a 24-hour span and a number of factors: hydrological and meteorological conditions, intensity and periods of division of phytoplankton organisms, degree of natural dying out and intensity of devouring phytoplankton by zooplankton. With those studies V. Petrova come into contact with one of the most important aspects of the problems of plankton dynamics and its significance for fish nutrition.

During the expeditions, besides the phytoplankton at the Bulgarian coastline, V. Petrova also studied the phytoplankton in the western part of the Black Sea: the northwestern part, the Romania coastline and the pre-Bosporus space. She confirmed the great abundance of phytoplankton in front of the estuary of the Danube. The phytoplankton in front of the western coasts of the northwestern part of the sea and in front of the Romanian coastline was more abundant than that in the Bulgarian aquatory. Monitoring the phytoplankton biomass from the Danube pre-estuary space to the pre-Bosporus space, V. Petrova found out that it gradually diminished.

Vyara Petrova proved that in spite of the different hydrometeorological conditions under which the phytoplankton developed in the northwestern part of the sea, the system of southwards directed currents transferred vast water masses rich in biogenic substances and phytoplankton, thus bringing to an equal footing qualitative composition and quantitative development of the mass species.

The results of the studies conducted by V. Petrova into the seasonal dynamics of the phytoplankton in

the Bulgarian aquatory and the expedition researches in the northwestern and pre-Bosporus space of the Black Sea showed the influence of inflowing waters of the Danube on the mass bloom in the coastal regions of the western half of the sea. V. Petrova studied the mass bloom of great duration and spatial range of *Rhizosolenia calcar-avis* Schul. (in 1955), *Nitzschia seriata* (1959), *N. delicatissima* Cleve (1966), and *Detonula confervaceae* (Cleve) Gran (1969), which proved very important for the elucidation of the impact of the Danube on the productivity of the Black Sea. V. Petrova reported the discharge of the Danube, respectively the biogenic outflow (the flow of biogenic salts), and the temperature of seawater as major factors determining the development of phytoplankton in the northwestern part of the Black Sea. Between these two factors, on the one hand, and the phytoplankton biomass, on the other, a distinct multiple correlation existed in spring, with a relatively high coefficient (R = 0.74). That correlation showed that the changes of one or another factor determine to a great extent the changes in the phytoplankton biomass itself. The Danube had a tangible impact on the development and distribution of phytoplankton in the western coastal regions of the Black Sea by the inflow of biogenic substances to the sea and creation of a powerful current in southward direction. The river determined the mass blooms influencing the general biological productivity in the sea. Depending on the nutritive value of the bloom-invoking species, the blooms played a positive or a negative role for the subsequent links in the food chain of the sea pellagial.

On the basis of 35-year-long systematic studies (1954–1990) V. Petrova revealed a change under the impact of euthrophisation in the dynamics and composition of the major sections of plankton algae, Bacillariophyta and Dinophyta, in the western part of the Black Sea and in the Bulgarian aquatory.

In the period 1954–1970 diatoms prevailed in numbers and weight over the dinophytes. The average biomass of the diatoms in front of the Bulgarian coastline in the spring months of 1954–1970 was 2801 mg/m^3. Correlation of the average biomass of diatoms and the average biomass of dinophytes in spring was 10:1. Diatoms caused local and regional blooms in the western part of the sea.

After 1970, owing to the inset of progressive euthrophisation in the western part of the Black Sea, under the impact of natural and anthropogenic factors and an increase of organic substances in the open Bulgarian aquatory, the development of dinophytes increased marking a sharp rise in the spring biomass, averaging on 3613 mg/m^3 for the period 1971–1980, while totally for the period 1971–1990 the biomass of the Dinophyta exceeded that of Bacillariophyta about four times.

The year 1971 witnessed the start of the first for the Bulgarian Black Sea Coast "red blooms", i.e. red tides caused by *Prorocentrum miminum* (Pavillard) Schiler (=*Exuviella cordata* Ost.) and *Prorocentrum micans* Ehr., with *Goniaulax polyedra* Stein, *Dinophysis caudata* Savill-Kent, *D. sacculus* Stein, etc. as accompanying species [37, 42, 43, 53].

Since 1954 and until 1987, expeditions of the Institute for Fish Resources monitored the dynamics and numbers of the biomass and structural changes of the phytoplankton in the Black Sea on annual and seasonal basis in the Institute's stations, using four established profiles, up to 30-40 miles off the Bulgarian coast. In the above-mentioned period 1100 shallow-water and deepwater stations were analysed. These investigations carried out in the Black Sea were important for disclosing the objective laws in the dynamics of plankton communities and as a basis for pollution diagnosis and prognostication in view of environmental protection. The main structural indicators of the phytoplankton (qualitative composition, numbers, and biomass) provided initial data both for biocoenological analysis and for pollution monitoring of the marine environment to which phytoplankton monitoring was related.

II. *Contributions to the phytoplankton of coastal lakes* [5,16,24]

Vyara Petrova carried out the first regular monthly studies of the quantitative and qualitative composition of the phytoplankton in Varna lake in the period 1953–1954. She identified 86 species, varieties and forms of *Cyanophyta* – one species, *Chrysophyta* (*Silicoflagellata*) – 3 species, *Bacillariophyta* – 48 species, four varieties and two forms, *Dinophyta* (*Pyrrophyta*) – 26 sepcies, and *Chlorophyta* – 2 species. An original contribution of hers was the elucidation of the vertical distribution of plankton, depending on the gas content of water. V. Petrova came to the conclusion that the abundance of phytoplankton in Varna lake provided a good nutritional stock for the

abundant zooplankton and underlay the feeding relations between plankton and plankton-eating fish, Sprat and Anchovy.

In the course of three years (1964–1967) V. Petrova studied the seasonal and annual dynamics of the composition and quantity of the phytoplankton in five big coastal lakes – Blatnitsa (Dourankoulak), Shabla, Beloslav (Gebedzhene), Bourgas (Vayakyoi), and Mandra lakes – in connection to the rational fish farming of these lakes. The species composition of the phytoplankton comprised 70 algal species: *Cyanophyta* (16), *Chlorophyta* (11), *Bacillariophyta* (33), *Euglenophyta* (7), *Dinophyta* (2), and *Chrysophyta* (1). She established the percentage correlation of phytoplankton quantity in the different seasons during three successive years (1964–1967) and manifested the importance of the summer-autumn phytoplankton in the lakes, which reflected the positive dependence of phytoplankton production on the summer-autumn temperatures of water in the lakes. During these three years of studies Bourgas lake showed the highest productivity of phytoplankton, followed by Blatnitsa and Mandra lakes. The high productivity of phytoplankton in these lakes outlined them as highly promising in terms of fishery.

The period 1967–1970 witnessed the continuation of studies into the seasonal and annual numbers of the phytoplankton in lake Bourgas and Mandra Dam. A comparison of the phytoplankton quantity in the two water basins during the period of research showed the phytoplankton in lake Bourgas as twice more abundant. The high total numbers of phytoplankton testified to the high biological productivity of the lake.

The results of the studies of coastal lakes were annually placed by the Institute of Fishery at the disposal of the Fishery State Economic Unit and were regularly used in fishery forecasting.

III. *Contributions to the problem of toxic phytoplanktonic species* [6,14,17]

Vyara Petrova was the first to engage in quantitative investigations of the "bloom" dynamics of the toxic species *Prymnesium parvum* Carter. In 1959 and 1963 that species caused the dying out of the ichtiofauna and most of the invertebrate fauna and strongly changed the composition of phytoplankton in the Varna lakes (Beloslav and Varna). Until then, there were only experimental data in literature on this species. There had been no detailed monitoring of the "bloom" of this species under natural conditions, accompanied with quantitative parameters. V. Petrova reaffirmed the experimentally known fact that low temperatures were the main factor for the low toxicity of natural waters, which explained the absence of mass dying out of fish during the periods of "bloom" in the Bourgas lake, Vaya.

Another contribution of V. Petrova were studies of the distribution of the rare plankton prokaryotic species *Anabaenopsis arnoldii* Apt. (*Cyanophyta*) in the biggest coastal lakes: Blatnitsa, Beloslav, Varna, Bourgas, and Mandra. She provided quantitative data about three blooms of this species in lake Bourgas (1962, 1965 and 1966). The 1962 bloom caused mass dying out of the fish in the lake. V. Petrova referred this species to the noxious, toxic plankton algae, which had to be chemically combated so as to prevent their bloom.

Vyara Petrova's studies into the toxic plankton algae were especially important for fishery practices and protection of the coastal lakes from dying out of fish. They proved the necessity of permanent monitoring of the phytoplankton status in the coastal lake waters. Of interest were, too, her laboratory experiments with copper sulphate, which showed that concentrations of 2 mg/l $CuSo_4$ had lethal effect on *Prymnesium parvum.* Unfortunately, that effective concentration was unprofitable, given the vast expanses of the Buglarian coastal lakes.

IV. *Contributions to some marine marcrophyte algae and sea grasses* [25,39]

To V. Petrova goes the credit for the first quantitative studies of *Cystoseira barbata* (Good et Wood) Ag. along the entire Bulgarian coastline (from the Romanian-Bulgarian frontier at cape Sibribouroun to river Rezovska at the Bulgarian-Turkish frontier), in order to elucidate the resources of this species. She calculated the total resources of *Cystoseira* along the Bulgarian coastline (340 000 t of wet weight, on an area of approximately 95 km^2), pointed out what portion of these resources could be used, allowing for the regenerating capacities of the algae, and offerred recommendations for its contiguous use in equally strong in numbers regions. The results of these four-year studies linked the name of V. Petrova to the construction project of a fodder mix works in Varna that was ex-

pected to use as raw material some of the *Cystoseira barbata* resources along the Bulgarian coastline.

Vyara Petrova was the first in Bulgaria to calculate the total and industrial resources of the sea grasses *Zostera marina* L. and *Z. nana* L. The total resources of *Zostera* in front of the Bulgarian coastline of the Black Sea amounted to 5000 t of wet mass and were locally important for the Bourgas district. V. Petrova maintained that mechanized production could yield 2000 t of wet mass at an output 4:1, with annual regeneration of the resources, owing to their spring leaf growth.

V. *Contributions to benthic diatoms of the Bulgarian Black Sea shelf* [49,50,56-58,60,62-64]

V. Petrova was involved by Prof. D. Temniskova in a five-ear project on studying the benthic diatoms of the Bulgarian Black Sea shelf immediately after the Chernobil accident (24th April 1986). The entire Bulgarian Black Sea shelf was studied on the basis of 43 coastal and 19 deep-water stations, by tacks and to a depth up to 50 m. The species composition of benthic diatoms was determined (over 300 species, varieties and forms belonging to 61 genera), as well as their abundance, and the dynamics of their numbers was traced out, plus the ecological data collected on the diatoms. Fifteen diatom communities were described: 11 from shallow-water rock substrates and four from surface sediments of the deep-water shelf. The obtained results were the only in their kind from that period for the shallow-water and deep-water Black Sea shelf. Proved was the possibility to use the composition and structure of marine benthic diatom communities under europhycation as indicators of the ecological status of the ecosystems. An indicator of the anthropogenic impact was determined, including the pollution with radionuclides and heavy metals for the Bulgarian Black Sea shelf: the centric species *Podosira pellucida* Pr.-Lavr.

Vyara Petrova was a greatly sought partner in the resolving of difficult practical tasks. She worked on projects of the Institute for testing Bulgarian-made antifouling toxic lacquer paints for the protection of ships and marine installations from various marine foulings. She studied the species composition of diatom foulings on experimental slabs in the period 1965–1968 and their indicative quantity for determining the quality of experimental antifouling paints and the degree of their detoxication [27]. V. Petrova proved that the method of quantitative study of diatom foulings was indicative and could be used only in the first three months of the autumn-winter-spring period (from October to June), when mass development of diatoms in the Black Sea waters was under way.

Vyara Petrova participated in a large team of specialists investigating the marine fouling organisms on antifouling coatings of sea vessels in the Black Sea [51].

The different degree of development of micro and macro phyto- and zoofouling organisms was investigated on experimental stands with antifouling coatings, on monthly and seasonal basis for the period 1987–1988. The team traced out the seasonal changes of growth in seawater in the aquatory of Varna Shipbuilding Works, which was practically important for technological decision-making in on-water shipbuilding.

Vyara Petrova was sought as a specialist by the Bourgas Oil Refinery. She rendered effective help to the Works, when there was an accident with the water tanks in its thermoelectric power plant, resulting from the mass development of *Cyanophyta* in the waters of Mandra Dam used by the Works.

Vyara Petrova participated in the writing of the first manual on hydrobiology in Bulgaria (1st ed. 1963; 2nd ed. 1967). It was written in co-authorship with I. Dimov and Zheni Lyutskanov and was intended for students of the Technical School for Ocean and Deep-Sea Fishing. The contribution of V. Petrova was the knowledgeable writing of the chapters on the phytoplankton, primary production and macroflora [65, 66].

In 1992 V. Petrova contributed 55 entries to the Encyclopaedic Dictionary in Oceanology [54].

Vyara Petrova was a great champion of marine biology in Bulgaria. She engaged in wide-ranging and diverse popular science activities. She wrote the booklet *Plant World of the Black Sea* (1961) and another one in co-authorship with P.Kolarov *Studying the Sea* (1963). The booklets were written in a popular and readable language and revealed in a popular manner some scientific data that could be of interest to the inquisitive reader. They were used by many teachers in biology for class and extra-class work [67, 68].

Vyara Petrova contributed many popular scence articles to various magazines and newspapers, reflecting on issues related to phytoplanktonologic re-

search in the Black Sea and coastal lakes, primary production of the water basins, seawater "blooms", characteristic genera of plankton and macrophyte benthic algae, phytoplankton as a source of marine life, algae as indicators of the sanitary status of seawater, marine fouling and shipping, plant resources of the Black Sea, use of marine macrophytes as an industrial raw material, etc. They all showed her great erudition as algologist and hydrobiologist. The articles were published in the magazines *Fishery* (nine articles), *Lighthouse* (9), *Nature and Knowledge* (4), *Nature* (1), *Protecting Nature* (1), *Health* (1), *Scuba Diving* [69-94]. Of the newspapers, V. Petrova published most frequently in Varna's *Public Cause* (44 articles), *Flight* (6), followed by *Beacon* (3), *Black Sea Front* (1) and in the national newspapers *Evening News* (2) and *Fatherland Front* (1) [95-152]. Her popular science articles in the magazines and newspapers amounted to over 80. She also published her translation of an interesting article in a foreign journal related to the promising use of underwater television in fishery.

Vyara Petrova participated in many broadcasts of Radio Varna with popular science lectures in the field of phytoplanktonology: composition, quantitative distribution and importance of the phytoplankton as food for the marine inhabitants. She wrote some interesting radio reports for the inquisitive listeners of the By Sea and Ocean programme: *The sea before us*, *Microscopic marine inhabitants*, *Algae of the Black Sea*, etc. and radio reports for Science in Aid of Fishing. She also took part in the radio broadcasts in foreign languages for the youth programme of Radio Sofia.

For many of us years slip by unnoticed and for V. Petrova, engrossed in the hasty rhythm of her *life dedicated to children and work, they simply flew out. She often exclaimed: "I seem to be running against time…"* Came April 28th 2002 and the big heart of V. Petrova stopped beating. Very emotional, sensitive and easily hurt, she was affected deeply by her personal and work problems. In her personal life V. Petrova suffered an early loss of her husband Dr Karadzhov. To that were then added the never ending changes in the administrative and scientific status of the Institute, as well as the subsequent unsuccessful reforms and gradual loss of the scientific and creative spirit, loss of the true image by her beloved Institute. All that did not crush her fighting spirit, but broke her heart. She had no time to summarise her studies into a much wanted monograph, though with her systematic and large-scale researches into the Black Sea phytoplankton she had established her name in Bulgarian marine hydrobiology and now stands out as one of the leading phytoplanktonologists of the Black Sea, with contributions to world oceanography.

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I. Publications of Assoc. Prof. Vyara Petrova-Karadzhova:

I. *1957–1999*

1957

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1961

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1964

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