

La Calera: Diatom composition of a Peruvian hot spring in the Colca canyon

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INTRODUCTION

The thermal spring of La Calera is located in the Peruvian Andes at 3 km northeast of Chivay (Fig. A). The spring is situated in the shallower part of the Colca canyon, on one of the world's deepest canyons (maximal depth of 3 269 m) and nowadays a famous tourist attraction for its condors and Inca and pre-Inca terraces which are still cultivated. Southeast of the canyon rises the extinct Nevado Ampato volcano (6 288 m asl), covered with perennial snow.

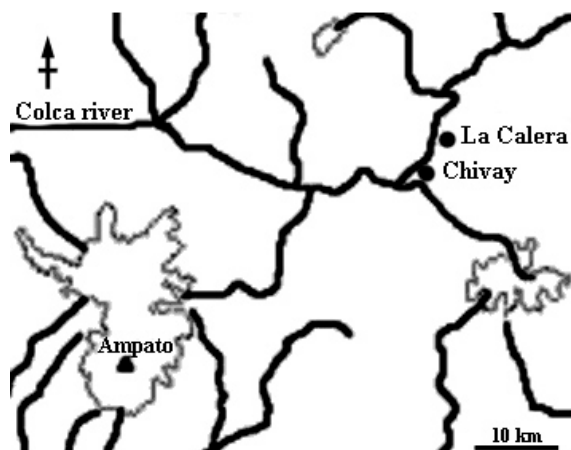


Fig. A. Map of the Colca region in the Peruvian Andes with indication of the thermal spring of La Calera near Chivay.

Like many other thermal springs in Peru, La Calera is commercially exploited and it is said to be curative for arthritis and rheumatism. Besides several salts, the water contains 30 % Ca, 18 % Zn and 19 % Fe. The source itself is located just outside the pool complex and is protected by a bricklaying construction. From there, the water is conducted towards the public pools by a series of small, uncovered canalized courses. This channel system allows the hot water ($\pm 85^{\circ}\text{C}$ at the source) to cool down to 38°C before it flows into the pools. The exploitation of the thermal spring is rather recent. Some 20 years ago, there was only a well surrounded by a small wall, which was visited by local people, probably dating back to the Inca or even pre-Inca period. However, nothing is known on its history or if it concerned a sacred place as many other thermal springs in the Peruvian Andes are known to be.

The diatom composition in this part of the Andes remains poorly studied. Manguin (1964) made some observations on Andean diatoms, describing several endemic taxa such as *Synedra pseudogoulardii* Manguin. Although one of the most recent studies, done by Rumrich et al. (2000), made an extensive survey of the Andean diatoms, the diatom flora of this part of the Colca area has never been thoroughly investigated.

MATERIAL & METHODS

Samples for diatom investigation of the thermal spring of La Calera were collected by C. Cocquyt on July 26, 2005 by scraping off algal material from stones at the source itself and on 3 different locations in the open channel system before entering the public pools. After cleaning the material with peroxide, permanent diatom slides were made by embedding in Naphrax®. Light microscopic investigations were performed with an Olympus BX 51 microscope equipped with Differential Interference Contrast and an Olympus Color View I digital camera. Material coated with gold was studied by means of a Jeol 5800 LV Scanning Electron Microscope equipped with the program ORION 7.1 for digitalizing the pictures. Beside the classic European and North American diatoms guides, publications dealing with South American diatoms were consulted for species determination, e.g. Frenguelli (1939), Manguin (1964), Rumrich et al. (2000).

RESULTS

A first investigation of the material of the thermal spring revealed a diatom diversity of more than 90 taxa; of which four appeared to be new to science: *Cymbella* sp., *Denticula* sp., *Fragilaria* sp. and *Navicula* sp. (described as new species in Van de Vijver & Cocquyt, submitted) (Fig. B: 1-4).

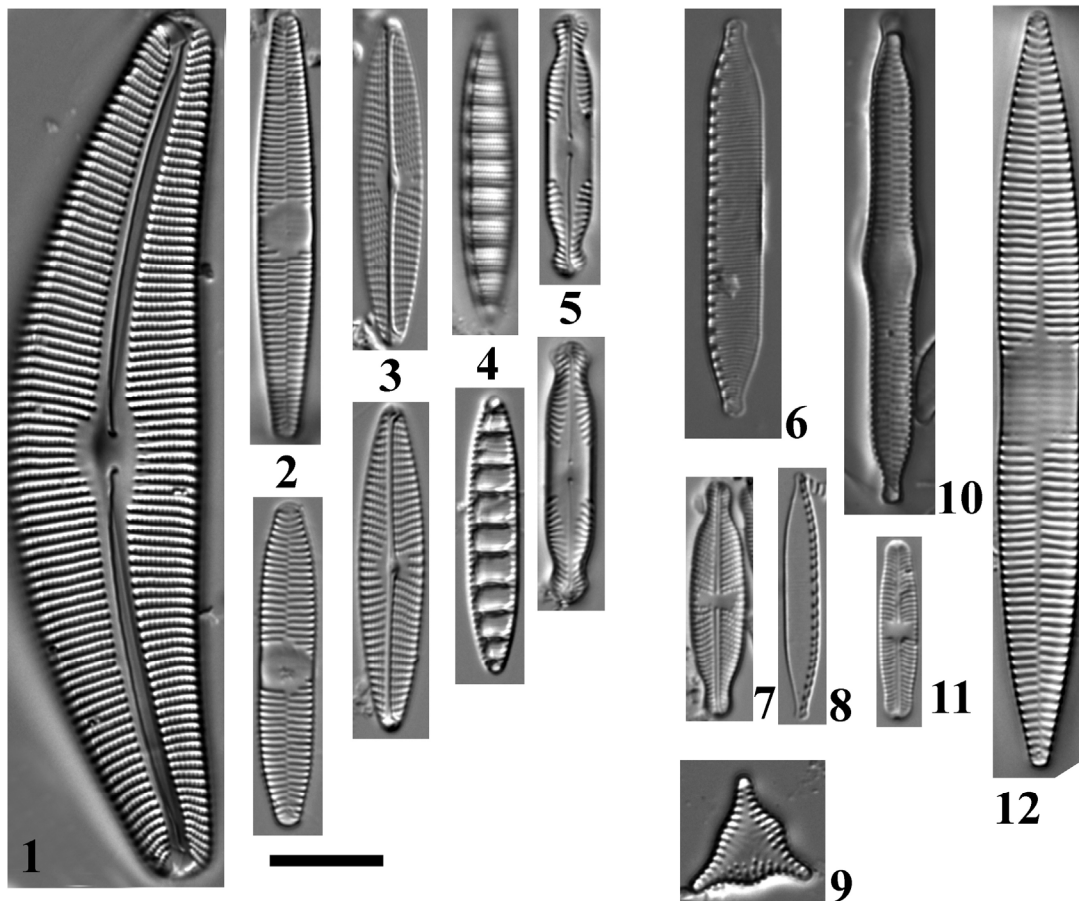


Fig. B: 1-12. LM micrographs. – 1. *Cymbella* sp. – 2. *Fragilaria* sp. – 3. *Navicula* sp. – 4. *Denticula* sp. – 5. *Pinnularia* sp. – 6. *Nitzschia chungara* Rumrich & Lange-Bert. – 7. *Stauroneis adamsiana* Metzeltin, 8. *Nitzschia vixnegligenda* Rumrich et al. – 9. *Staurosira laucensis* var. *vulpina* Lange-Bert. & Rumrich, 10. *Fragilaria inflata* var. *sublinearis* Manguin. – 11. *Naviculadicta chilensis* (Krasske) Lange-Bert. – 12. *Fragilaria pseudogoulardii*. – Scale bar = 10 µm.

At the outcome of the source, where the water temperature fluctuated around 85°C, the diatom composition was restricted to less than 10 species with *Pinnularia jocolata* Manguin as dominant taxon. The diversity increased with decreasing temperature; water temperature of the sample site located farthest from of the source was still 50°C. *Achanthes exigua* Grunow and *Nitzschia amphibia* Grunow were the dominant taxa from the open channels close to the source. Amongst the commonly observed diatoms figures *Nitzschia palea* (Kütz.)

W.Sm., the new *Denticula* sp. and the new *Navicula* sp. Another new taxon, belonging to the genus *Fragilaria*, was observed in the canalized courses.

Typical Andean taxa that have been observed include *Fragilaria inflata* var. *sublinearis* Manguin, *Frankophila similioides* Lange-Bert. & Rumrich *Naviculadicta chilensis* (Krasske) Lange-Bert., *Nitzschia chungara* Rumrich & Lange-Bert., *Nitzschia vixnegligenda* Rumrich et al., *Stauroneis adamsiana* Metzeltin et al., *Staurosira laucensis* var. *vulpina* Lange-Bert. & Rumrich and *Synedra pseudogoulardii* Manguin (Fig. B: 6-13).

DISCUSSION

The diatom flora of the thermal spring of La Calera seems to be an interesting site for taxa with a distribution restricted to South America. Four of the observed taxa are new to science and their description is in preparation (Van de Vijver & Cocquyt submitted). Although typical South American species were observed in the investigated samples, most diatoms lack a restricted biogeography. However the typical South American diatoms were never common in the samples, except the two new taxa belonging to *Denticula* and *Navicula*. Moreover, most observed diatom taxa cannot be considered to be stenothermal, which is in agreement with the flora of other thermal springs worldwide (e.g. Cassie 1989, Cocquyt & Mpawenayo unpublished data).

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REFERENCES

- Cassie, V. 1989: A contribution to the study of New Zealand diatoms. – *Bibliotheca Diatomologica* **17**: 1-266.
- Frenquelli, J. 1939: Diatomeas del Lago Titicaca. – *Noticias del Museo del La Plata* **4**: 175-196.
- Krammer, K. & Lange-Bertalot, H. 1986: Bacillariophyceae. 1. Teil: Naviculaceae. – In: Ettl, H., Gerloff, J., Heynig, H. & Mollenhauer, D. (ed.): Süßwasserflora von Mitteleuropa. **2(1)**. – Stuttgart.
- Manguin, E. 1964: Contribution à la connaissance des diatomées des Andes du Pérou. – *Mémoires du Muséum national d'Histoire naturelle, nouvelle série B, Botanique* **12(2)**: 1-98 + 25 plates.
- Rumrich, U., Lange-Bertalot, H. & Rumrich, M. 2000: Diatoms of the Andes. From Venezuela to Patagonia/Tierra del Fuego. *Phytogeography-Diversity-Taxonomy*. – *Iconographia Diatomologica* **9**: 1-672.
- Van de Vijver, B. & Cocquyt, C. (submitted.): Four new species from La Calera hot spring in the Peruvian Andes (Colca Canyon). – *Diatom Research*.