Photometric properties of microfossil shells

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The chromatic characteristics of fossil planktonic foraminifera were measured with the use of an opticoelectric microscope and a new aspect of their nature has been revealed.

Planktonic foraminifera are unicellar microrganisms which belong to the Kingdom of Protista and evolve mainly calcite skeletons in spiral forms with equations characteristic for each species[1]. These shells can be considered as calcite prisms. The tests were exposed to radiation of different temperature, their interaction was recorded digitally in a computer and the results are presented below. Quantification of the recorded radiation in each of the color channel used from the Red Green Blue (RGB) computer color model revealed that every group of fossils exhibits a specific chromatic imprint. Here it is shown that different fossil species can be identified by their different color patterns.

Methods Skeletons of foraminifera of size between 315-355μm were utilized for the present study. Twenty shells of five different species were separated from surface samples of surficial sediments of the Atlantic Ocean. The tests were cleaned in a methanol ultrasonic bath to avoid any contamination of the measurements from finer particles and were orientated under an optic microscope connected to a computer via a camera. The sampling of the photographs, in the different white temperatures, was performed under a light source of stable intensity with the use of Cell® electronic filters. The photographs of the samples were then analyzed with *Image J* software into the three basic color channels and the light radiation histograms were calculated for every channel. The number of pixels recorded with a specific gray level value multiplied with this gray value was theorized as an estimate of energy. By applying this integration the quantity of the basic colors detected for every sample was calculated as a percentage of the total recorded radiation. The values of the measurements are presented in the figure 1.

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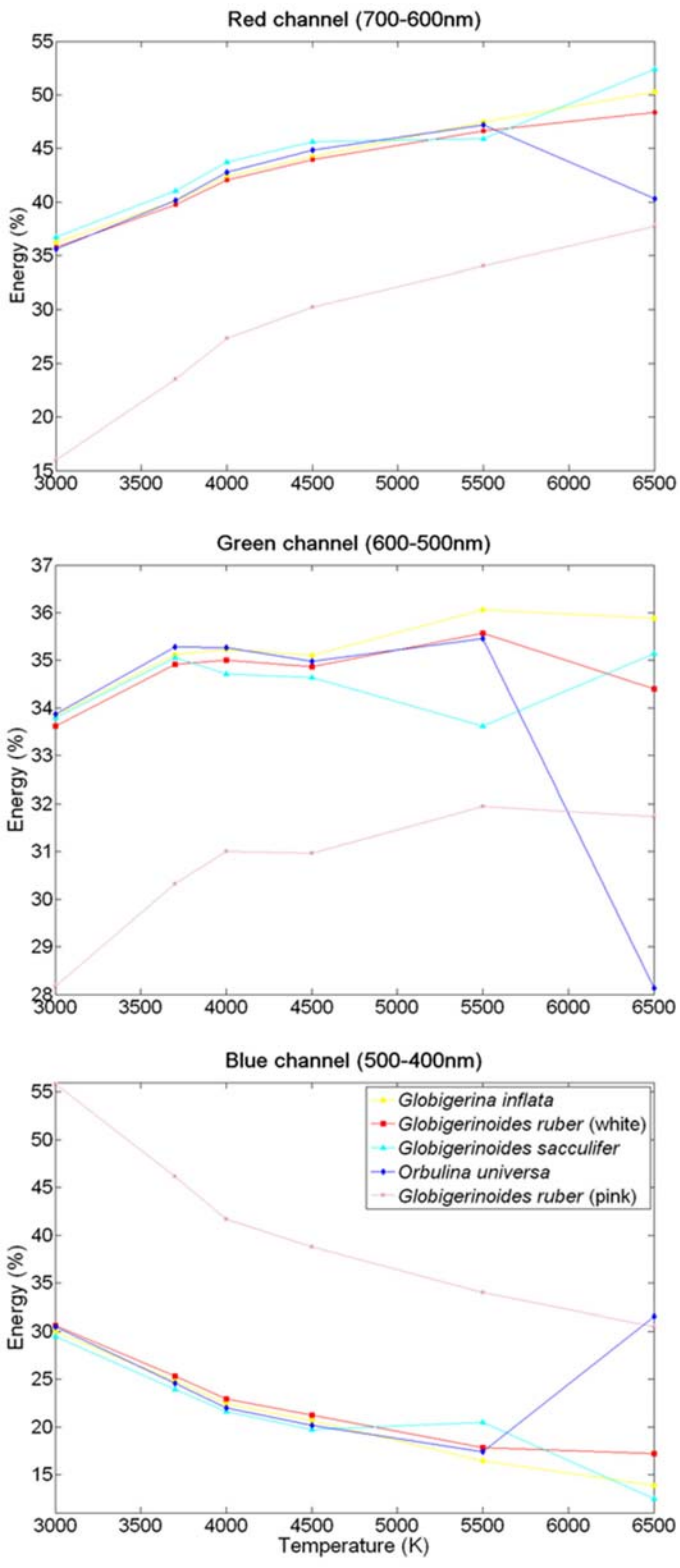

Figure 1 | Quantity of radiation recorded in every chromatic channel when light, of different temperature, interacted with different calcite spiral prisms. The used tests, biogenic in origin, are shells of five different foraminifera species.

Measurements were performed both under incident and reflected light with alike results. The data presented here are incident light measurements from a light source at the base of the microscope. The values acquired with this method were considered more reliable for presentation due to the leptokurtic nature of their histograms, which exhibit steeper gradients and the easiness in defining threshold values between the background and the sample.

From the graphs it becomes apparent that each skeleton type corresponds differently to light of different temperatures. For temperatures exceeding the temperature of 6,000K artefacts, in the measurements, appear. Increasing the light temperature the quantity of energy in the red channel seems to increase against the blue radiation, while in the green region energy variations appear smaller. Shells of the species *Globigerinoides ruber* (pink) became exceptionally distinct from the computer, as well, due to their pink color. The chromatic patterns of the rest four species appear to differentiate particularly with radiation from the middle part of the visible spectrum with wavelength from 600 to 500nm. In this region, where the green tones appear, it is known that the human eye is also very sensitive[2]. Although the causes of such a response are still unknown, the above identified properties can optimize automated fossil classification systems by complementing algorithms which are entirely based on the recognition of their morphological characteristics.

1. Thompson, D. A. W., *On Growth and Form*. Cambridge University Press, Cambridge (1992).
2. Chartier, G., *Introduction to Optics*. Springer, New York (2005).

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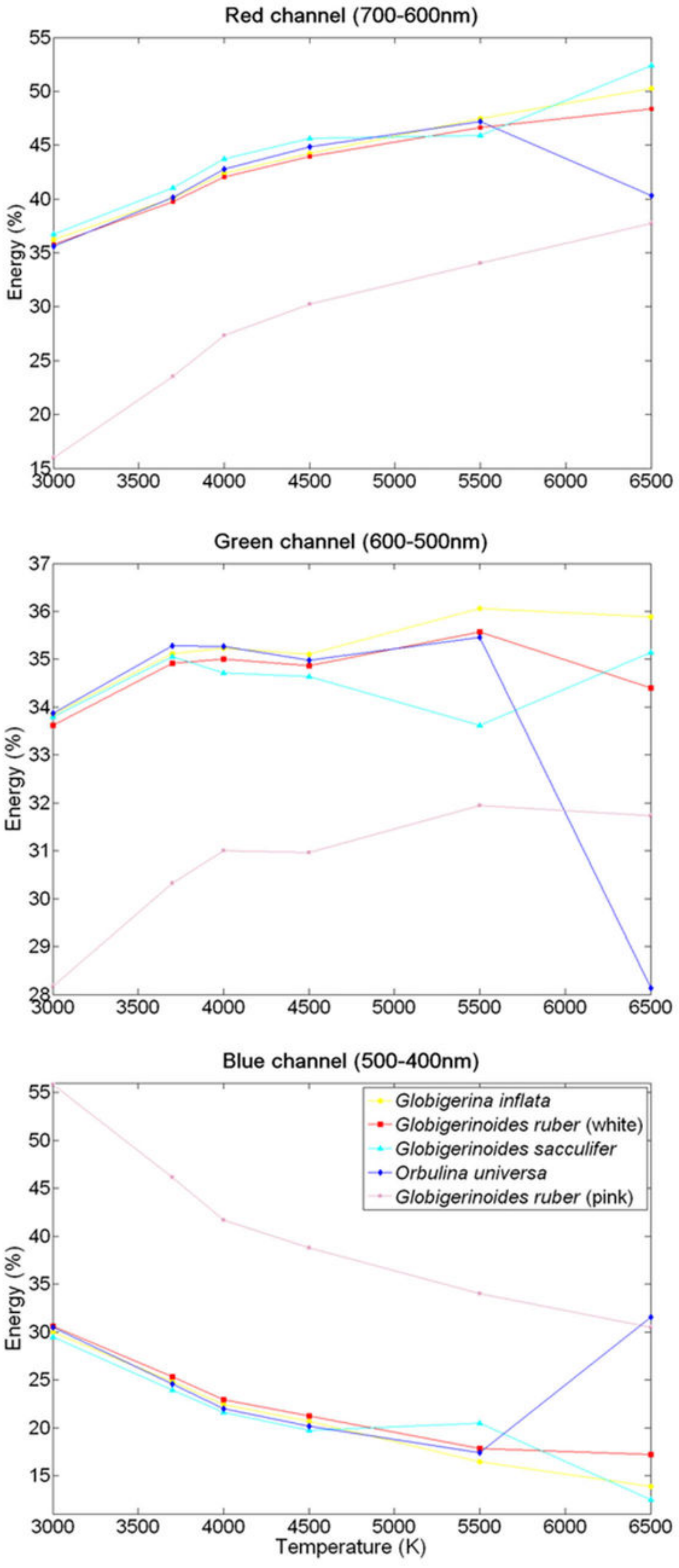
Red channel (700-600nm)
Green channel (600-500nm)
Blue channel (500-400nm)
Energy (%)
Temperature (K)
3000
3500
4000
4500
5000
5500
6000
6500
Globigerina inflata
Globigerinoides ruber (white)
Globigerinoides sacculifer
Orbulina universa
Globigerinoides ruber (pink)