

The acritarch *Proteolobus wallii* gen. et sp. nov. from the Devonian Iquiri Formation of Bolivia: a possible coenobial alga

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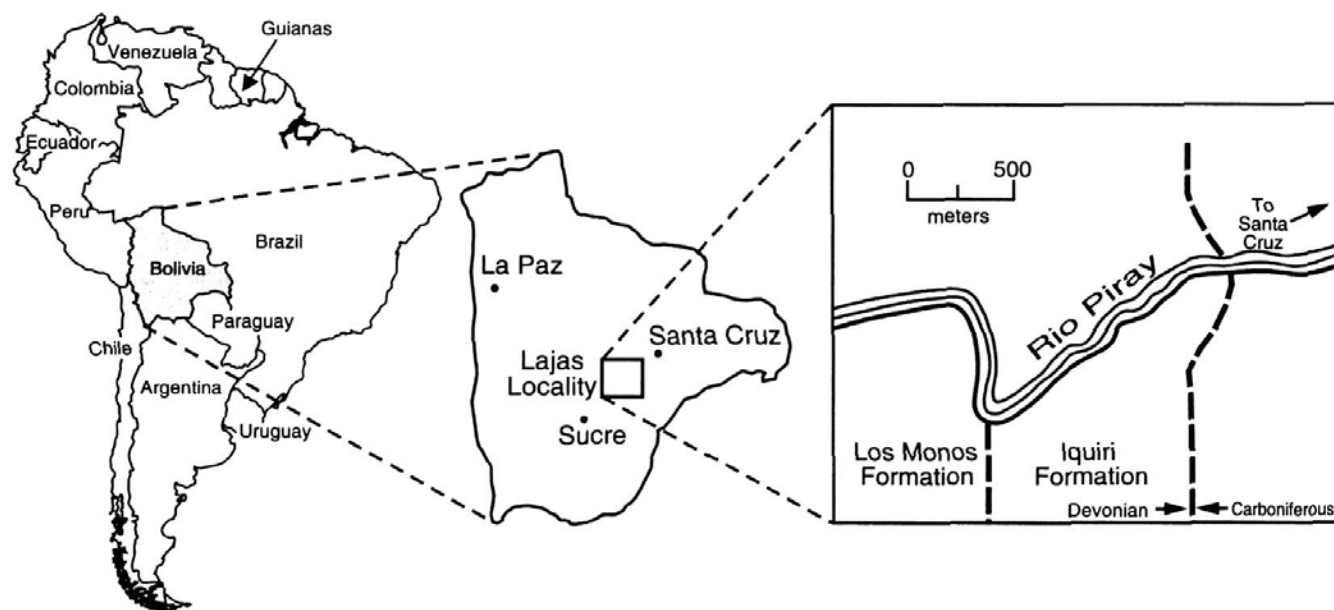
ABSTRACT: *Proteolobus wallii* gen. et sp. nov. is described and illustrated from the Iquiri Formation (Devonian), Sierras Subandinas region, Bolivia. This new acritarch has a variable morphology consisting of two to twelve lobate processes that originate from a central point. The predominance of specimens with even-numbered processes suggests that *Proteolobus* may be a type of coenobial alga.

INTRODUCTION

Devonian sediments outcrop in the Eastern Cordillera, Altiplano and Subandean zones of Bolivia. The stratigraphy and paleoecology of the Bolivian Devonian has been discussed at length by Ahlfeld (1956), Barrett and Isaacson (1989) and Isaacson and Sablock (1989, 1990). The succession consists of clastics and can achieve a thickness of 4,500m locally. The sample reported on here was collected from the Subandean Zone and deposited in a cold water (Malvinokaffric Realm) intercratonic basin (Isaacson and Sablock 1989, 1990; Wood 1981).

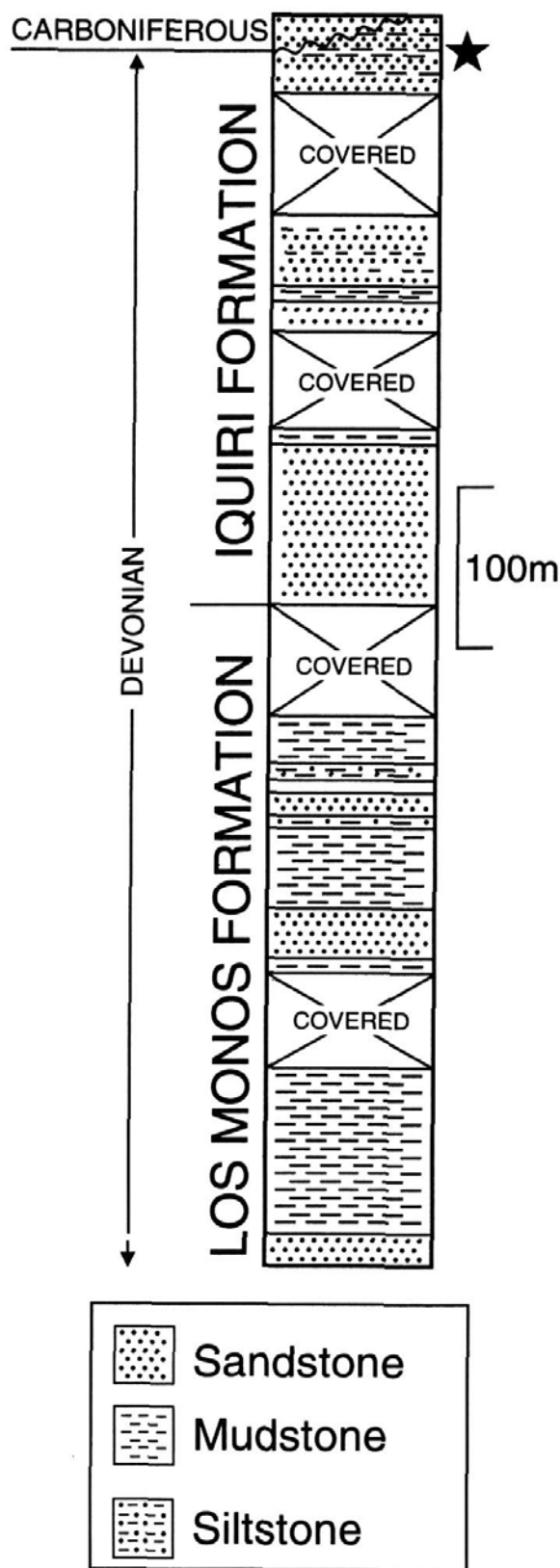
GEOLOGY AND STRATIGRAPHY

Barrero (1975), Padula and Reyes (1960), Pugielsi and Murillo (1975), Suárez-Soruco (1983), Wood (1994; in press) and Wood and Isaacson (1992) have studied the palynomorphs of the Iquiri Formation in both outcrop or subsurface equivalents. The sample yielding *Proteolobus wallii* gen. et sp. nov. was collected from the Lajas locality of Isaacson (1977a, b) and Isaacson and Sablock (1989), of the Sierras Subandinas region of Bolivia. The section is located south of the Rio Piray (text-figure 1). At this locality, the Iquiri is approximately 410m thick (including interpolated covered intervals), bounded at the base by the Los



TEXT-FIGURE 1

Generalized map showing the location of the Lajas section (after Isaacson 1977a; Isaacson and Sablock 1989).



TEXT-FIGURE 2

Generalized representation of the exposure at the Lajas locality. The star indicates sampled horizon yielding *Proteolobus wallii* gen. et sp. nov. (from Isaacson and Sablock 1989; Isaacson, personal communication, 1994).

Monos Formation and at the top by an unnamed Carboniferous sandstone (see text-figure 2). The Iquiri Formation at Lajas is composed of micaceous sandstone and siltstone with thin dark mudstone interbeds (Isaacson 1977a,b; Suárez-Soruco 1983; Isaacson and Sablock 1989).

The Iquiri Formation has been assigned ages spanning the Eifelian through Frasnian. For example, Pugielski and Murillo (1975) and Barrero (1975) suggest an age of Givetian-Frasnian based on macrofossils and palynology. These authors assign the Iquiri Formation to the *Verrucosisporites* and *Maranhites brasiliensis* palynomorph zones. Lobo-Boneta (1975) and McGregor (1984) also reported *Maranhites* from the Iquiri Formation. Pérez-Leyton (1990) places the Iquiri Formation in the Frasnian based on miospores. The recovery of *Maranhites mosei* and *Lagenochitina avelinoi* from the upper Iquiri Formation near Santa Cruz prompted Racheboeuf et al. (1993) to assign it a late Frasnian age.

The accessory palynomorph assemblage from the sample yielding *Proteolobus wallii* gen. et sp. nov. is diverse and very well preserved. This assemblage includes *Ancyrospora* spp., *Apiculatisporites* spp., *Apiculiretusispora* spp., *Convolutispora* spp., *Cymatiosphaera* spp., *Duvernaysphaera angelae*, *D. tenuicungulata*, *Emphanisporites rotatus*, *Estiastra* sp., *Gorgonisphaeridium* spp., *Horologinella* sp., *Hymenozonotrites* spp., *Leiofusa* sp., *Maranhites brasiliensis*, *Maranhites* sp., *Multiplisphaeridium* spp., *Navifusa bacilla*, *Palacanthus ledanoisii*, *Polyedryxium fragosulum*, *P. pharaone*, *Retusotrites* spp., *Sphaerochitina* sp., *Stellinium micropolygonale*, *S. comptum*, *Tapajonites* spp., *Tasmanites* spp., *Tetraletes* spp., *Tunisphaeridium* spp., *Urochitina* cf. *U. bastoi*, *Veryhachium lairdii* and *Veryhachium trispinosum* complex. The assemblage suggests a Givetian-Frasnian age date.

MATERIALS AND METHODS

Proteolobus wallii gen. et sp. nov. was recovered from a gray-black shale sampled by Dr. P. E. Isaacson (Department of Geology, University of Idaho-Moscow) approximately 26m below the top of the Iquiri Formation at the Lajas locality (text-figure 2). Palynomorphs were isolated using standard palynological techniques (Wood et al. 1996). Specimens for SEM (Scanning Electron Microscopy) were picked from a methanol bath using a hand-drawn micropipette and transferred onto a circular coverslip. The coverslip was mounted on an SEM stub using colloidal silver paint, coated with gold and photographed using a International Scientific Instruments ABT-55 SEM. Photomicrographs were taken in interference contrast using a Leitz Orthoplan microscope (stage No. 986086). Type specimens are housed at the Orton Geological Museum, The Ohio State University, 155 South Oval Mall, Columbus, Ohio, 43210. Each type specimen is assigned an Orton Geological Museum (OSU) number.

SYSTEMATICS

Algae *incertae sedis*

Group Acritarcha Evitt 1963

Genus *Proteolobus* Wood gen. nov.

Type species: *Proteolobus wallii* sp. nov.

Derivation of Name: *Proteus*, Latin (masculine), a sea god capable of changing his form; *lobus*, Latin (masculine), an elongated projection or protuberance.

Diagnosis: Vesicle is composed of two or more hollow processes that radiate from a common point. No central body is present. Processes rarely communicate with one another; a wall or plate may be present at the point of contact. No excystment structure observed.

Remarks: The overall population is dominated by specimens with even numbered processes arranged primarily in a planar geometry suggesting that *Proteolobus* gen. nov. may be a coenobial alga. This is further supported by the fact that processes are connected at one common point and are essentially the same shape and size on individual specimens.

The morphological term "process" as used in the diagnoses refer to the lobes/protuberances. The term "cell" (or coenocytes) usually employed for algal coenobia is not used because the affinity of *Proteolobus* is unknown at this time.

If *Proteolobus* is proven to be a chlorococcalean algae it may be of value in palynofacies study of the Gondwanan Devonian. The presence of this alga, in particular the morphological variation in process number, may reflect physical and chemical changes in the environment. These fossils may provide indications of paleosalinity and temperature conditions.

Comparisons: *Quadrulobus* Tappan and Loeblich 1971 has four spinule bearing processes in a single plane. *Deflandrastrum* Combaz 1962 possesses a central lumen formed by the arrangement of four elongated triangular cells. *Pulvinosphaeridium* Eisenack 1954 and *Rhiptosocherma* Loeblich and Tappan 1978 have broad-based radiating processes and a distinct vesicle.

***Proteolobus wallii* Wood gen. et sp. nov.**
Plate 1, figures 1-6; Plate 2, figures 1-5

Derivation of Name: This species is named in honor of Dr. David Wall for his many contributions to the study of living and fossil dinoflagellates and prasinophytes.

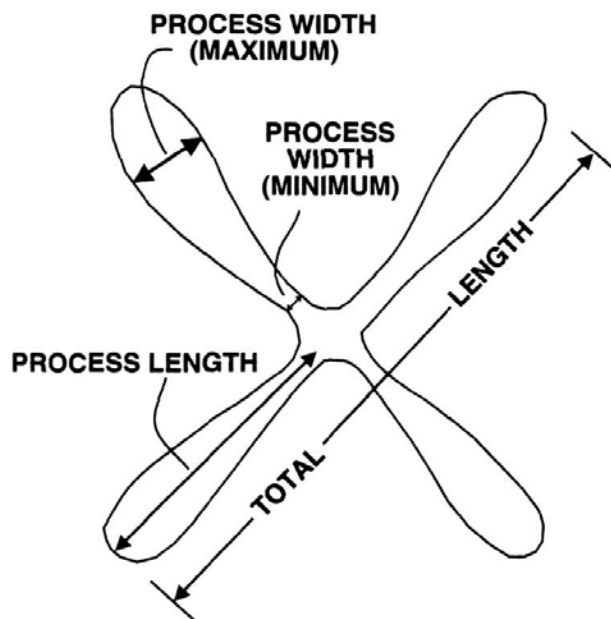
Holotype: Slide 35242-A-1, Leitz Orthoplan coordinates 17.2/97.7, England Finder coordinates F17/3, Ohio State University Orton Geological Museum Type Repository Number 48441; Plate 1, fig. 5.

Paratypes: Slide 35242-A-1, Leitz Orthoplan coordinates 31.4/108.7, England Finder coordinates R31/4, Ohio State University Orton Geological Museum Type Repository Number 48442; Plate 1 fig. 1.

Slide 35242-A-1, Leitz Orthoplan coordinates 27.2/104.9, England Finder coordinates 027/1, Ohio State University Orton Geological Museum Type Repository Number 48443; Plate 1, fig. 3.

Slide 35242-A-1, Leitz Orthoplan coordinates 21.2/100.2, England Finder coordinates J20/2, Ohio State University Orton Geological Museum Type Repository Number 48444, Plate 1, fig. 4.

Slide 35242-A-1, Leitz Orthoplan coordinates 41.1/106.9, England Finder coordinates Q41/2, Ohio State University Orton Geological Museum Type Repository Number 48445, Plate 1, fig. 6.



TEXT-FIGURE 3

Diagrammatic representation of *Proteolobus wallii* gen. et sp. nov. showing morphological characters measured.

Slide 35242-A-7, Leitz Orthoplan coordinates 12.9/107.2, England Finder coordinates Q12, Ohio State University Orton Geological Museum Type Depository Number 48446, Plate 2, fig. 1.

Slide 35242-A-7, Leitz Orthoplan coordinates 15.7/107.3, England Finder coordinates Q15, Ohio State University Orton Geological Museum Type Repository Number 48447, Plate 2, fig. 2.

Type stratum: The type specimens of *Proteolobus wallii* gen. et sp. nov. were recovered from a sample collected approximately 26m beneath the top of the Iquiri Formation exposed at the Lajas locality (18°16' S. Latitude; 65°33' W. Longitude), Bolivia (Isacson 1977a; Isaacson and Sablock 1989).

Diagnosis: Vesicle single layered, composed of two to twelve (typically four) hollow, lobate processes radiating from a common point. No central body is present. The processes are widest near their extremities and the tips are rounded, commonly bulbous. The processes taper uniformly to the point of origin where their interiors are usually closed to one another by a wall or plate. Vesicle surface smooth. No excystment structure observed.

Measurements (see text-figure 3): Process length: 51 (74) 96µm (holotype 52µm); process width (narrowest) 5 (11) 14µm (holotype 10µm); process width (widest) 16 (18) 32µm (holotype 18µm); total length (process tip to process tip) 99 (142) 188µm (holotype 99µm); number of processes 2 (4) 12 (holotype 4). Twenty-five specimens measured (values in parentheses are averages).

Remarks: Regali (1964; fig. 11, no. 14) illustrates a line-drawing of an unnamed palynomorph from the Devonian of the Tucano-Jatobá Basin that superficially resembles *Proteolobus*

wallii gen. et sp. nov. This form appears to possess processes with bulbous terminations. The absence of a morphological description does not allow detailed comparison. The Silurian acritarch *Cuatrifolia fortunata* described by Cramer et al. (1976) has a distinct central body and processes are not as elongate as *Proteolobus* gen. nov.

ACKNOWLEDGMENTS

Dr. P. E. Isaacson (Department of Geology, University of Idaho-Moscow) collected the sample and graciously provided additional geographic and geologic information. Additional information and translations were provided by A. Aleman and J. Rosenfeld (Amoco Production Company - Houston). Sincere appreciation is given to M. A. Miller (Amoco Exploration & Production Technology Group - Houston) for critiquing the manuscript. H. M. Kuriger and W. W. Dorsey (Amoco Exploration & Production Technology Group - Houston) were involved in sample processing and scanning electron microscopy, respectively. M. Schendel drafted the text-figures and V. Kenworthy typed the manuscript. The author gratefully acknowledges Amoco Exploration & Production Technology Group for technical support and permission to publish.

REFERENCES

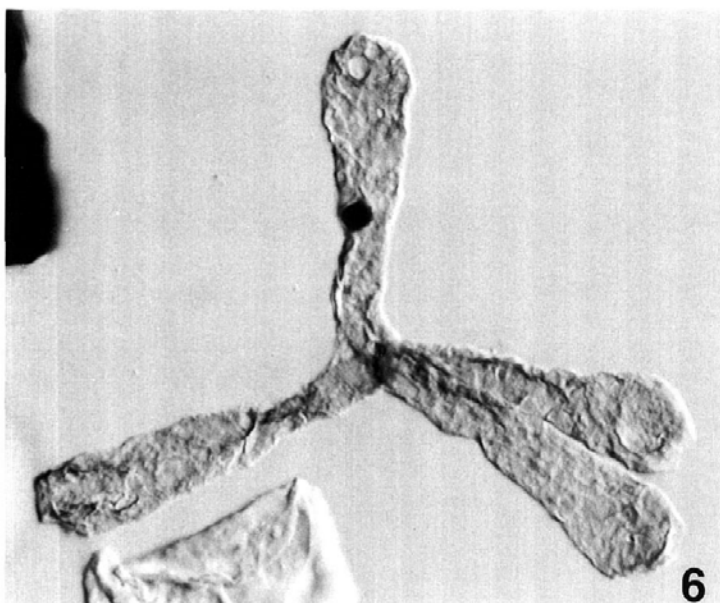
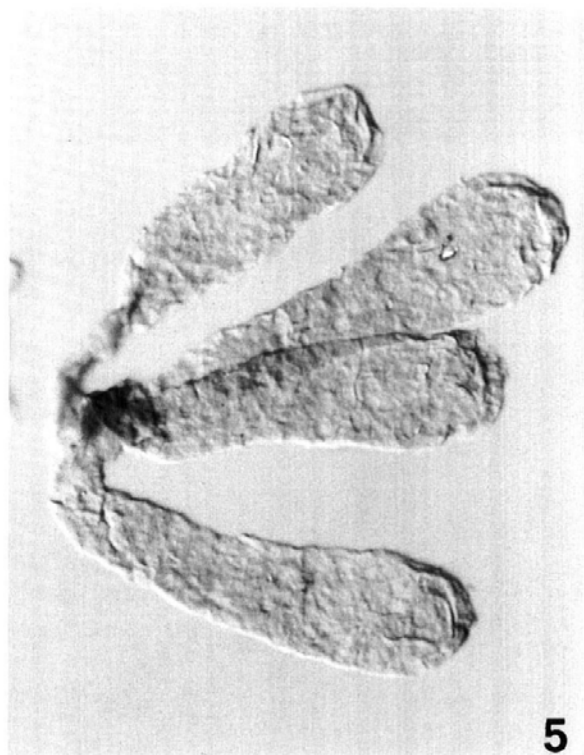
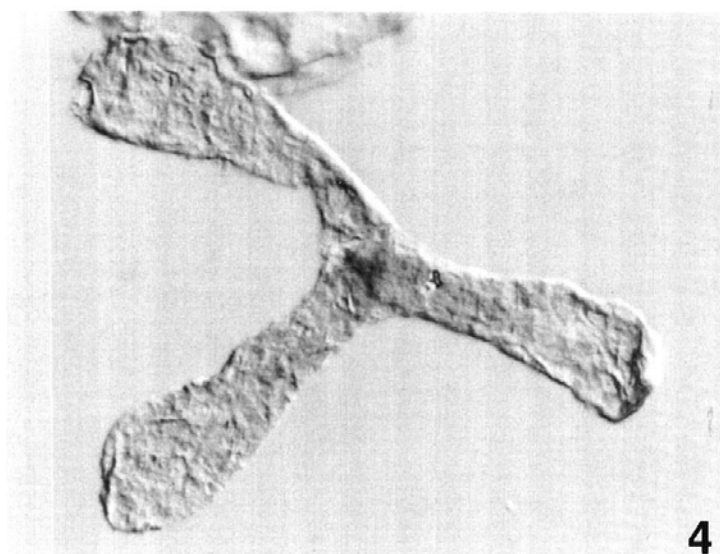
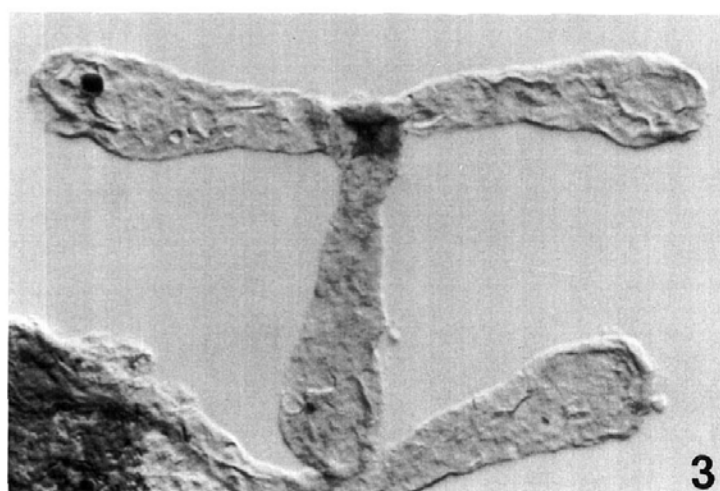
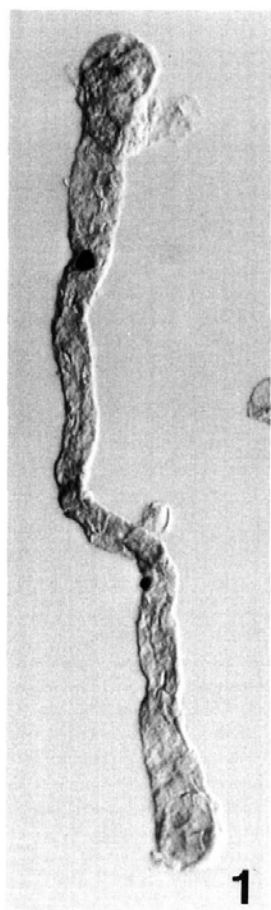
- AHLFELD, F., 1956. Bolivia. In: Jenks, W. F. (ed.), *Handbook of South American Geology*. Geological Society of America, Memoir, 65: 169-186.
- BARRERO, I.M.R., 1975. El sistema Devónico en el Subsuelo de Santa Cruz. *Anales IV Convención Nacional de Geología, I, Publicación Especial Revista Técnica de Yacimientos Petrolíferos Fiscales Bolivianos*, 4: 327-353.
- BARRETT, S.F., and ISAACSON, P.E., 1989. Devonian paleogeography of South America. In: McMillan, N. J., Embry, A. F., and Glass, D. J. (eds.), *Devonian of the World*, Canadian Society of Petroleum Geologists, Memoir, 14: 655-667.
- CRAMER, F.H., DIEZ, M. del C.R., RODRIGUEZ, R.M., and FOMBELLA, M.A., 1976. Acritarcos de la Formación San Pedro (Silurico Superior) de Torrestio, Provincia de Leon, España. *Revista Española de Micropaleontología*, 8(8): 439-452.
- ISAACSON, P.E., 1975a. Evidence for a western extra continental land source during the Devonian Period in the central Andes. *Geological Society of America, Bulletin*, 86: 39-46.
- , 1975b. Faunal evidence of a Devonian transgression and regression in Bolivia, Tucuman. *Actas, Primer Congreso Argentino de Paleontología y Bioestratigrafía*, 1: 39-46.
- , 1977a. Devonian stratigraphy and brachiopod paleontology of Bolivia, part A: Orthida and Strophomenida. *Palaeontographica*, 155A: 133-192.
- , 1977b. Devonian stratigraphy and brachiopod palaeontology of Bolivia, part B: Spiriferida and Terebratulida. *Palaeontographica*, 156A: 168-192.
- ISAACSON, P.E., and SABLOCK, P.E., 1989. Devonian System in Bolivia, Peru and northern Chile. In: McMillan, N.J., Embry, A.F., and

PLATE 1

Specimens of *Proteolobus wallii* gen. et sp. nov. are from palynological maceration number 35242.

Specimens are located by slide number, Leitz Orthoplan coordinates and England Finder coordinates (e.g., A-1, 41.7/99.3, N23/4). All photomicrographs X 675 unless otherwise specified.

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|---|---|
| 1 <i>Proteolobus wallii</i> gen. et sp. nov. (Paratype), A-1, 31.4/108.7, R31/4; X 535. | 4 <i>Proteolobus wallii</i> gen. et sp. nov. (Paratype), A-1, 21.2/100.2, J20/2. |
| 2 <i>Proteolobus wallii</i> gen. et sp. nov., A-1, 20.9/105.0, P20. | 5 <i>Proteolobus wallii</i> gen. et sp. nov. (Holotype), A-1, 17.2/97.7, F17/3. |
| 3 <i>Proteolobus wallii</i> gen. et sp. nov. (Paratype), A-1, 27.2/104.9, 027/1. | 6 <i>Proteolobus wallii</i> gen. et sp. nov. (Paratype), A-1, 41.1/106.9, Q41/2; X 595. |



- Glass, D.J. (eds.), Devonian of the World, Canadian Society of Petroleum Geologists Memoir, 14: 719-728.
- , 1990 Devonian palaeogeography and palaeobiogeography of the central Andes. In: McKerrow, W.S., and Scotese, C.R. (eds.), Palaeozoic Palaeogeography and Biogeography, Geological Society Memoir, 12: 431-435.
- LOBO-BONETA, J., 1975. Sobre algunos palinóforos del Devónico superior y Carbónico inferior de la zona Subandina sur de Bolivia. *Annales IV Convención Nacional de Geología, I, Publicación Especial Revista Técnica de Yacimientos Petrolíferos Fiscales Bolivianos*, 4: 159-176.
- MCGREGOR, D. C., 1984. Late Silurian and Devonian spores from Bolivia. *Academia Nacional de Ciencias, Miscelanea* 69: 1-43.
- PADULA, E.L., and REYES, F.C., 1960. Contribución al Lexico Estratigráfico de las Sierras Subandinas. *Boletín Técnico Yacimientos Petrolíferos Fiscales Bolivianos*, 2: 9-70.
- PÉREZ-LEYTON, M., 1990. Miospores du Dévonien moyen et supérieur de la coupe de Bermejo-La Angosturma (Sud-est de la Bolivie). *Annales Société géologique Belgique*, 113(2): 373-389.
- PUGIELSSI, J.M.L., and MURILLO, R.D.L., 1975. Estratigráfica de los Sistemas Silurico y Devonico de Bolivia. *Annales IV Convención Nacional de Geología, I, Publicación Especial Revista Técnica de Yacimientos Petrolíferos Fiscales Bolivianos*, 4: 233-264.
- RACHEBOEUF, P.R., LE HÉRISSÉ, A., PARIS, F., BABIN, C., GUILLOCHEAU, F., TRUYOLS-MASSONI, M., and SUÁREZ-SORUCO, P., 1993. Le Dévonien de Bolivie: biostratigraphie et chronostratigraphie. *Compté Rendu Académie Sciences Paris*, 317: 795-802.
- REGALI, M.S.P., 1964. Resultados palinológicas de amostras paleozoicas da bacia de Tucano-Jatabá. *Boletín Técnico Petrobrás*, 7(2): 165-180.
- RIGLOS, I.M.S., 1975. Distribución estratigráfica de algunos fósiles Silurico-Devónicos. *Revista Técnica de Yacimientos Petrolíferos Fiscales Bolivianos*, 4: 213-233.
- SUÁREZ-RIGLOS, M., 1975. Algunas consideraciones bioestratigráficas del Silurico-Devónico en Bolivia Tucumán. *Actas, Primer Congreso Argentino de Paleontología y Bioestratigrafía*, 1: 293-317.
- SUÁREZ-SORUCO, R., 1983. Síntesis del desarrollo estratigráfico y evolución tectónica de Bolivia durante el Paleozoico Inferior. *Revista Técnica de Yacimientos Petrolíferos Fiscales Bolivianos*, 9: 223-228.
- WOOD, G.D., 1981. A stratigraphic, paleoecologic and paleobiogeographic review of the acritarchs *Umbellaspheeridium deflandrei* and *Umbellaspheeridium saharicum*. In: Sutherland, P.K., and Manger, W.L. (eds.), *Compté Rendu, Biostratigraphy, Ninth International Congress on Carboniferous Stratigraphy and Geology*, v. 2, Southern Illinois University Press: 191-211.
- , 1994. *Togachitina*, a new bilayered chitinozoan genus from the Devonian of the Sierras Subandinas Region, Bolivia. *Palynology*, 18: 195-204.
- , 1995. The Gondwanan acritarch *Bimerga bensonii* gen. et sp. nov.: paleogeographic and biostratigraphic importance in the Devonian Malvinokaffric Realm. *Palynology*, 19: 221-231.
- WOOD, G.D., and ISAACSON, P.A., 1992. Palynomorphs from the Bolivian central Andean Devonian: Implications for paleobiogeographical comparison between Gondwanaland and Eurasia. *International Palynological Congress, Abstracts and Programs (Aix-en-Provence, France)*: 171.
- WOOD, G.D., GABRIEL, A.M., and LAWSON, J.C., 1996. Palynological techniques - processing and microscopy. In: Jansonius, J., and McGregor, D.C. (eds.), *Palynology: principles and applications*, American Association of Stratigraphic Palynologists Foundation, v. 1: 29-50.

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PLATE 2

Specimens of *Proteolobus wallii* gen. et sp. nov. are from palynological maceration number 35242.

Specimens are located by slide number, Leitz Orthoplan coordinates and England Finder coordinates (e.g., A-1, 41.7/99.3, N23/4).

All photomicrographs X 675 unless otherwise specified.

- 1 *Proteolobus wallii* gen. et sp. nov. (Paratype), A-7, 12.9/107.2, Q12.
- 2 *Proteolobus wallii* gen. et sp. nov. (Paratype), A-7, 15.7/107.3, Q15; X 550.
- 3 *Proteolobus wallii* gen. et sp. nov., SEM stub 35242-1; X660
- 4 *Proteolobus wallii* gen. et sp. nov., SEM stub 35242-1 (same specimen as figure 3); X2,300. The texture of the wall is considered an artifact of preservation.
- 5 *Proteolobus wallii* gen. et sp. nov., SEM stub 35242-1 (same specimen as figure 3); X2,300.

