Observations of PP 0943

SINCE October 1969, a pulsar has been observed with the approximate position, period and dispersion reported for the pulsar PP 0943 (refs. 1 and 2). Measurements have been made using the 300 m diameter radio telescope at Arecibo at radio frequencies of 73·8, 111·5, 196·5, 318·0 and 606·0 MHz.

The purpose of this letter is to provide more accurate values of the basic parameters of this pulsar as an aid to other investigators. The properties of PP 0943 are summarized in Table 1, together with previous measurements for comparison.

Table 1. PARAMETERS OF THE PULSAR PP 0943

Parameter	Arecibo observation	Pushchino observation[1,2]
R.A. (1950·0)	09 h 43 m 19·6 s ± 20 s	09 h 43 m 15 s ± 30 s
Dec. (1950·0)	10° 05′ 33″ ± 5′	8° ± 4°
Dispersion measure	15·35 ± 0·01 cm^{-3} pc	17·5 cm^{-3} pc
Period	1·097707 ± 0·000003 s (Barycentric, October 25, 1969, epoch JD 2440520·00668657758)	1·093 ± 0·003 s
Galactic longitude	225·4°	
Galactic latitude	43·1°	
Average peak flux at 111·5 MHz	~2 flux units	

This source has been found to be quite variable, on time scales ranging from seconds to days, as previously reported[1,2]. The average pulse shape is basically triangular with a half-power width of 50 ms ± 14 ms. The pulse width does not seem to vary with frequency within the experimental errors. The flux density seems to fall quite rapidly with frequency and the source has not as yet been detected reliably at 606 MHz.

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Sea Level at −175 m off the Great Barrier Reef 13,600 to 17,000 Year Ago

THE shelf around Australia, like many other continental shelves[1], has its edge chiefly[2–5] at depths of 120 to 130 m and is marked locally by terraces and notches, which register low stands of the sea during the Quaternary. From radiometric dates of shallow water fossils recovered from terraces in different parts of the world the lowest eustatic level of the sea during the past 35,000 yr is estimated to be −130 m, 16,000 yr ago[6]. More recent information, principally from Australian waters, suggests that the sea level may have stood much lower during this period. Dill[7] and Conolly[4] found submerged terraces with shallow water fossils and sediments between depths of 175 to 238 m in 39 of 78 narrow beamed echo sounder profiles made all around Australia. The continuity and consistent depth of the terraces indicate that there has been little tectonic warping of the continental margin since the terraces were formed. Similar features are reported off southern and Baja California[7], and a shallow water mollusc from a deep terrace off Baja California has a radiocarbon date of 14,380 ± 190 yr BP. Another record of shallow water fossils of similar age and depth relates to the south-eastern Caribbean Sea[8], where fragments of algae and hermatypical corals at a depth of 157 m (Station index 1,203) have radiocarbon dates of 13,590 ± 270 and 13,800 ± 330 yr BP, and algae at 187 m (Station index 1,202) a date of 14,220 ± 350 yr BP. These organisms did not necessarily live at sea level[6] but, being reef dwellers, probably indicate shallow water. To date, the evidence from Australia is only morphological. Here we describe the occurrence and radiometric dates of two shallow water specimens collected *in situ* from deep terraces off the Great Barrier Reef during descents by J. J. V. in the Japanese research submersible Yomiuri in February 1969.

The outer shelf and upper slope off One Tree Island in the Capricorn Group of the southern Great Barrier Reef[9,10] (Fig. 1) were traversed by the submersible and its mother ship, and four echo sounder profiles were made from the mother ship. The outer reefs of the Capricorn Group grow on a terrace at 65 m (Maxwell's[10] 36 fathom terrace) about 10 km shoreward of the shelf edge[9]. Beyond the shelf edge the upper continental slope, with gradient about 1°, drops off through a zone of rough topography, especially between 80 and 100 m and at 165 m, to a wide plain at 600 m.

Two rock samples were collected with the mechanical arm of the submersible, on either side of a terrace at 165 m. At a depth of 175 m in traverse BB′ (Fig. 1), muddy sand and platy rocks were observed from the submersible on a terrace too narrow to be detected by the wide beam echo sounder in the ship. A large coral colony measuring 50 cm by 20 cm was collected from this terrace, and was identified[11] as *Galaxea clavus* (Dana). It is a characteristic shallow water reef coral, although it has been observed to occur at 25 m in the Maldives and occasionally as deep as 75 m at Bikini and Jamaica (personal communication from J. W. Wells, Cornell University). Beneath its grey surface, encrusted with a few bivalves and worm tubes, the specimen is essentially pure aragonite (≥ 98 per cent), as shown by X-ray diffraction, except for some grey-green clay that fills a few cavities.

From 175 m to 73 m the submersible traversed an almost continuous pavement of shells and rock that show through a thin layer of shelly sand. Above the 100 m wide terrace at 165 m, so conspicuous in the echo-sounding profiles, a second specimen was collected from a narrow terrace at 150 m. This was a plate of pale brown fossiliferous calcarenite, which is seen under the microscope to consist of grains of branching *Lithothamnion* (30 per cent), coral, foram, mollusc and echinoderm debris (25 per cent), quartz (10 per cent), voids (30 per cent) and fine carbonate cement (5 per cent). Lithologically this is beachrock, a determination confirmed by the recognition (personal communication from W. F. Ponder, Australian Museum) of many of the larger fossils as shallow water species of gastropod. This specimen is therefore a precise indicator of former water level. Some of the larger fossils were identified (W. F. Ponder) as *Nerita melanotragus* Smith, *Phasianella* sp., *Pyrene opulens* Woolacott, *Pyrene* sp., *Strombus* (*Dolomena*) *dilatatus dilatatus* Swainson and *Prothalotia* sp. Radiocarbon dates, determined by Isotopes Inc., are 13,860 ± 220 yr BP for the beachrock (Station index JJV1) and 13,600 ± 220 yr BP for the coral (Station index JJV3). The coral was also dated by the uranium series method (Table 1).

Table 1. ISOTOPIC DATA AND ^{230}Th AGES OF *Galaxea clavus*

U (p.p.m.)	^{234}U/^{238}U (activity ratio)	^{230}Th/^{234}Th (activity ratio)	Age (yr)
3·01 ± 0·05	1·15 ± 0·01	0·14 ± 0·01	17,000 ± 1,000
3·03 ± 0·05	1·17 ± 0·01	0·14 ± 0·01	17,000 ± 1,000

The small but significant difference between the radiocarbon and ^{230}Th dates of the coral may be the result of (1) systematic error in the uranium series age determination, (2) violation of a basic assumption in either the radiocarbon or the uranium series method, or (3) secondary alteration of the coral specimens. Before a proper evaluation of these alternatives can be made, further cross-checks between the radiocarbon and uranium series