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A NEW SPECIES OF *CTENOTUS* (SCINCIDAE) FROM CENTRAL QUEENSLAND

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Ctenotus rosarium sp. nov., from the Desert Uplands Bioregion of central Queensland is readily distinguished from its congeners by a combination of head scalation (presubocular single, contacting only the subocular supralabial), subdigital lamellae (narrowly callose) and colour pattern (dorsum immaculate between a pale-edged, black vertebral stripe and narrow, black, laterodorsal stripe). The new species occurs in spinifex-dominated open woodland and prefers high hummock grass cover on sandy soils. □ *Ctenotus rosarium* sp. nov., Scincidae, Desert Uplands, Queensland, Australia.

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The Desert Uplands Bioregion of Queensland lies within Australia's northern tropical savannas, straddling the Great Dividing Range between Charters Towers, Hughenden and Blackall (Fig. 1). It borders the Einasleigh Uplands, the Mitchell Grass Downs and the Northern Brigalow Belt (Stanton & Morgan, 1977). This bioregion has been little surveyed, contrasting sharply with coastal eastern Queensland. Australian arid/semi-arid communities are recognised as reptile 'hotspots' (Wilson & Knowles, 1988). Discovery of a new *Ctenotus*, described herein, suggests that the Desert Uplands, with its rich mosaic of acacia and eucalypt woodlands, ephemeral lakes, dune systems and grasslands, is deserving of more attention. The integrity of these habitats is threatened by multiple land-use pressures.

The new *Ctenotus* was first collected from White Mountains National Park in 1994 but the very small sample of one adult and two subadults, one of which was poorly preserved, prevented accurate determination. A further 10 well-preserved specimens now in the Queensland Museum collection enables a formal description.

Because of the large species complement, their frequent sympatry and morphological similarity, *Ctenotus* species have attracted numerous studies on habitat partitioning and ecological interactions (James, 1991; Pianka, 1986; Pianka, 1996; Read, 1998; Sadlier, 1987; Twigg et al., 1996). Yet, for many species, habitat preferences are poorly known and the original description remains the only published information. The

voucher specimens were collected as part of a survey incorporating detailed habitat assessment, hence we are also able to define habitat parameters for the new species.

MATERIALS AND METHODS

The new *Ctenotus* was found in close proximity to the similarly-patterned *C. strauchii*. In the field, they were readily separated by a consistent difference in laterodorsal pattern (a narrow, sharply defined stripe in the former vs a broad stripe, containing a series of pale blotches).

All body measurements were taken using Mitutoyo electronic callipers. Supraciliaries, supralabials, infralabials and subdigital lamellae on the fourth toe were counted on both sides of specimens examined. These bilateral counts were averaged for each specimen. The total number of enlarged nuchals is given. Only original tails were included in the morphometric analysis (assessed by eye only). Abbreviations for body measurements are as follows: snout-vent length (SVL); axilla to groin (AG); tail length (vent to tip, TL); forelimb (axilla to tip of longest digit, L1); hindlimb (groin to tip of longest digit, L2); head width (widest point, HW); head length (tip of snout to posterior margin of parietals, HL); snout (tip to anterior margin of orbit, S); eye to ear (posterior margin of orbit to dorsal anterior margin of ear, EE). Comparative details of scalation characters and colour patterns of *Ctenotus* spp. were assessed largely from the descriptions and photographs of Cogger (2000), Hutchinson & Donnellan (1999), Horner (1992), Storr et al. (1999) and Wilson & Knowles (1988)

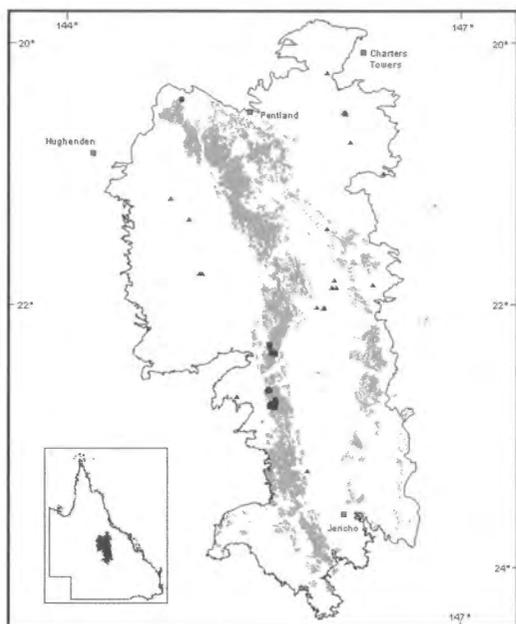


FIG. 1. Map showing trapping localities for *C. rosarium* (bold circle) and *C. strauchii* (bold triangle) in the Desert Uplands bioregion, including the potential distribution for *C. rosarium* according to regional ecosystem association (grey shaded area). Map sources: AUSLIG (1992), Queensland Herbarium (June 2001), Queensland Environmental Protection Agency (1998).

focussing on the *C. schomburgkii* group (Storr, 1981, Shea, Sadler & Swan, unpublished data). Colour pattern terminology follows Wilson & Knowles (1988). Scalation definitions follow Horner (1992).

Broad-scale surveys were conducted within the Desert Uplands (ASK, 1997-2000) to assess vertebrate assemblages of the regional ecosystems (*sensu* Sattler & Williams, 1999). Sampling utilised a standardised nested quadrat array as the basic trapping unit (after Woinarski & Fisher, 1995), using pitfall, Elliott and cage traps over a 96 hour period, and timed active searches.

Detailed habitat variables measured at each site were: location, altitude, season, landform, distance to water, level of fire, weed and cattle disturbance, % cover of ground strata elements (rock, tussock and hummock grass, bare ground, sedges, forbs, ferns), soil characteristics (colour, texture, degree of cracking), log and litter cover, height, cover, diversity and basal area of vegetation strata. Mann-Whitney-U tests were

conducted to identify environmental variables determining presence or absence of the new *Ctenotus*.

SYSTEMATICS

The current diagnosis of *Ctenotus* Storr, 1964 is not based on derived characters. Our assignment rests on the following external characters (Cogger, 2000): limbs pentadactyl, absence of supranasal scales, eyelids moveable and scaly, parietal scales in contact behind the interparietal, conspicuous anterior ear lobules, smooth body scales, and a colour pattern of dorsal and lateral longitudinal stripes and other markings. The type series is deposited in the Queensland Museum.

Ctenotus rosarium sp. nov. (Figs 2-4)

ETYMOLOGY. Latinised English – rosary beads; a noun in apposition. Alluding to the series of pale blotches along the lateral zone which resembles a string of beads.

MATERIAL. HOLOTYPE QMJ72577 Fortuna Stn, 50km N Aramac (22°43'50"S, 145°35'39"E). PARATYPES QMJ58559-61 White Mountains NP, Hughenden (20°26'48"S 144°50'05"E); QMJ68680 Fortuna Stn, 45km N Aramac (22°45'51"S 145°35'35"E); QMJ72578 type locality; QMJ72579-80, Fortuna Stn, 50km N Aramac (22°44'46"S 145°35'47"E); QMJ72751-3 Bede Stn, 110km NNE Aramac (22°22'15"S 145°35'00"E); QMJ73350 Albionvale Hstd, 100km N Aramac (22°18'14"S 145°33'01"E); QMJ73655, White Mountains NP (20°26'32"E 144°52'35"E).

DIAGNOSIS. Maximum adult SVL in type series = 43.8mm (maturity assessed by gonad examination); 26-29 midbody scale rows. Colour pattern most like that of southwestern *C. schomburgkii* (dorsum immaculate between a pale-edged, black vertebral stripe and narrow, black laterodorsal stripe, upper lateral zone black with a single series of pale blotches, Fig. 4). It is distinguished from all similarly-patterned *Ctenotus* spp. by the following characters combined: presubocular single (Fig. 5), usually greatly reduced and contacting only the subocular supralabial (usually 5th); prefrontals moderate, widely separated (Fig. 3); subdigital lamellae narrowly callose.

DESCRIPTION. *Measurements*. SVL (mm) 26.6-43.8 (mean=39.1, standard deviation, S.D. =5.0, n=12). Proportions (%SVL): AG= 47.1-52.4 (mean=48.9, S.D.=2.0, n=12); TL= 164-210 (mean=192, S.D.=17, n=5); L1= 29.5-36.2 (mean=32.4, S.D.=1.89, n=12); L2= 47.3-57.0 (mean=52.2, S.D.=3.1, n=12); HL=



FIG. 2. *Ctenotus rosarium* in life, paratype QMJ73350 from Albionvale Hsd, 100km N Aramac (22°18'14"S 145°33'01"E). (photograph by A.S. Kutt)

20.2-25.2 (mean=21.5, S.D.=1.3, n=12). Proportions (%HL): HW=55.8-67.6 (mean=63.1, S.D.=3.9, n=13); S=42.5-48.3 (mean=45.4, S.D.=1.7, n=13); EE=35.8-44.8 (mean=39.8, S.D.=2.7, n=13).

Scalation. Nasals in narrow to moderate contact; nasal groove absent; prefrontals moderate, widely separated; maximum length of frontal 1.6-1.9 times maximum width, (mean=1.7, S.D.=0.1, n=13); frontal usually contacts frontonasal, prefrontals, first three supraoculars (rarely two, QMJ72751 & QMJ58559 one side only) and frontoparietals, and is narrowly separated from first supraciliary (rarely in contact, QMJ72752, QMJ72580, QMJ72579 both sides; QMJ73655 one side only); supraoculars four, second largest; supraciliaries 6-8 (mean=7.2, S.D.=0.6, n=13), first largest; frontoparietals paired and distinct from interparietal; enlarged nuchals 7-11 (mean=8.5, S.D.=1.4, n=13); loreals 2, second largest; preoculars 2; presubocular single, usually greatly reduced and contacting only the subocular supralabial (Fig. 5A; see Variation in Paratypes); supralabials 7, 5th subocular, rarely 5, 3rd subocular (QMJ72753 one side only) or 8, 6th subocular (QMJ68680 both sides); infralabials 6, rarely 7 (QMJ58560 one side only), 2-3 in contact with postmental (mean=2.1, S.D.=0.3, n=13); ear opening large, vertically elliptic with 3-8 lobules on anterior edge; Midbody scale rows 26-29 (mean=27.7, S.D.=1.0, n=12); paravertebral scales, from anterior-most nuchal to posterior margin of hindlimb, 55-64 (mean=58.7, S.D.=2.7, n=12); lamellae beneath fourth toe

19-26 (mean = 22.5, S.D. =1.6, n =13), narrowly callose, pigmented; a single row of supradigital scales present along almost the entire length of the fourth toe.

Measurements and scale counts for the holotype (QMJ72577) are: SVL=40.5mm; AG=21.2mm; TL=78.5mm; L1=13.6mm; L2=21.8mm; HW=5.7mm; HL=8.7mm; S=4.1mm; EE= 3.32mm; maximum length of frontal 3.8mm; maximum width of frontal 2.2mm; supraciliaries 8, first largest; enlarged nuchals 10; supralabials 7, 5th subocular; infralabials 6; ear lobules 7; midbody scale rows 28; paravertebrals 55; lamellae beneath fourth toe 23.

Colour Pattern. Dorsal ground colour bronze. Longitudinal stripes and zones are: vertebral black and narrow with pale edging (Fig. 4, stripe 5), extending from nuchals to base of tail; narrow black laterodorsal (Fig. 4, stripe 4), bordered below by copper dorsolateral (Fig. 4, stripe 3); broad chocolate brown upper lateral zone, commencing at tip of snout and extending full length of tail, containing a single series of copper blotches along flanks (Fig. 4, stripe 2); midlateral white from loreals to tail (Fig. 4, stripe 1); lower

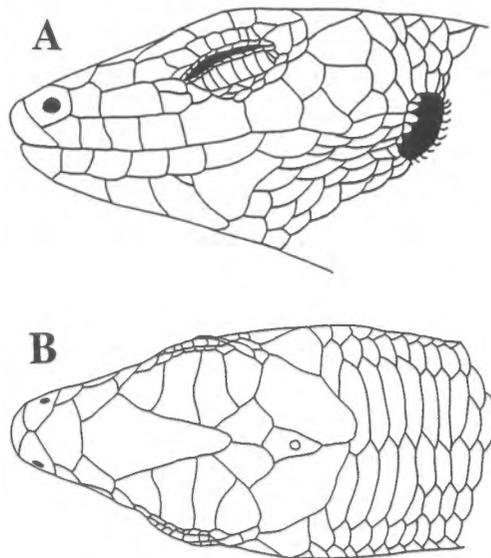


FIG. 3. *Ctenotus rosarium*, holotype, QMJ72577, head in lateral (A) and dorsal (B) views.

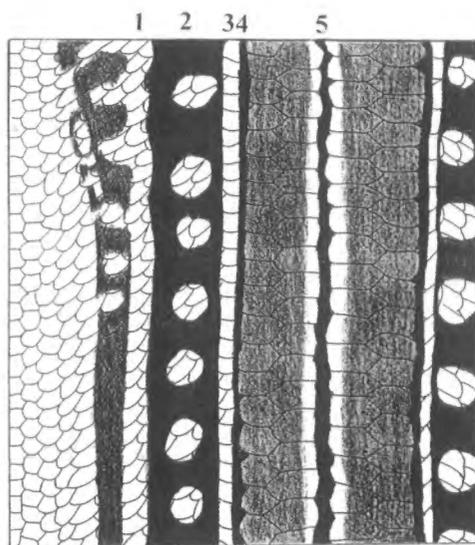


FIG. 4. Schematic diagram (after Storr et al., 1999) showing the colour pattern of *C. rosarium*. 1 = midlateral stripe, 2 = upper lateral, 3 = dorsolateral, 4 = laterodorsal, 5 = vertebral.

lateral dark brown, containing obscure anterior blotches; ventral surface white; limbs bronze with dark brown stripes.

Variation in Paratypes. In QMJ72751 and QMJ72753 the presubocular contacts both the preocular supralabial and the subocular supralabial (QMJ72753 left side only). In QMJ58561 the pale blotches of the upper lateral zone appear as a double series because the pale dorsolateral stripe is fragmented. In QMJ58559, QMJ72753 and QMJ73655 the vertebral stripe is incomplete (confined to nuchal area QMJ58559; disappearing half way between the axilla and groin QMJ72753; present on anterior body and base of tail QMJ73655).

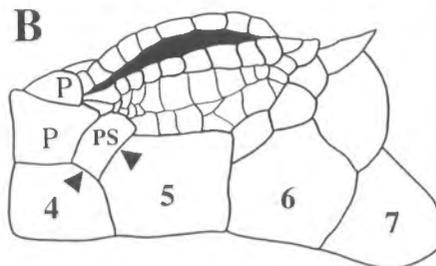
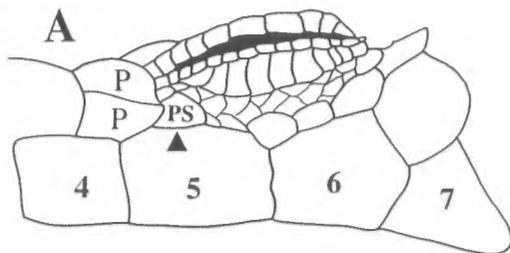


FIG. 5. Comparison of presubocular/supralabial contact between A. *Ctenotus rosarium* holotype QMJ72577, B. *Ctenotus strauchii*, QMJ58660. P = preocular, PS = presubocular, 4-7 = supralabials.

COMPARISON WITH OTHER SPECIES. *Ctenotus rosarium* can be distinguished from other similarly-patterned *Ctenotus* spp. by the combination of characters given in the diagnosis. In colour pattern, it is most like the *C. schomburgkii* group (*allotropis*, *brooksi*, *schomburgkii*, *strauchii*, and *tantillus*). It is distinguished from these, except *C. brooksi*, by the presubocular/supralabial contact (presubocular greatly reduced and contacting subocular supralabial only [Fig. 5A], vs presubocular contacting preocular supralabial and subocular supralabial [Fig. 5B]), apart from aberrant specimens (Table 1). The narrowly callose subdigital lamellae (vs sharply keeled lamellae) further separates *C. rosarium* from all members of the *C. schomburgkii* group, except *C. allotropis*, which differs in dorsal pattern (*C. rosarium* with a narrow, sharply defined laterodorsal stripe vs a broad laterodorsal stripe, containing a series of pale blotches). The only species outside the *C. schomburgkii* group with which *C. rosarium* can be confused are *C. monticola* (to which it would key in Cogger, 2000) and *C. arnhemensis*. It is separated from both by the presubocular/supralabial contact (Fig. 5). It is further separated from *monticola* by upper lateral pattern (single row of spots vs spots forming transverse bars) and *arnhemensis* by the width of the vertebral stripe (very fine vs moderately wide).

DISTRIBUTION. *Ctenotus rosarium* occurs in a narrow band of deep red sandy earths, between 20°S-23°S in the Desert Uplands Bioregion. (Fig. 1), where it is strongly associated with particular vegetation and soil types.

HABITAT. *Ctenotus rosarium* is a terrestrial, diurnal lizard occurring in spinifex-dominated open woodlands. The species was found sheltering beneath dense spinifex hummocks and within burrows located in their bases. Trapping shows greater activity during summer (3.0 per

TABLE 1. Frequency of presubocular/supralabial contact states shown in Fig. 5.

Species	5A both sides	Sides different	5B both sides
<i>Ctenotus rosarium</i>	11	1	1
<i>Ctenotus allotropis</i>	0	0	10
<i>Ctenotus arcanus</i>	0	0	16
<i>Ctenotus arnhemensis</i>	0	0	6
<i>Ctenotus brooksi</i>	38	3	3
<i>Ctenotus hilli</i>	0	0	6
<i>Ctenotus monticola</i>	0	0	3
<i>Ctenotus nullum</i>	0	0	12
<i>Ctenotus schomburgkii</i>	5	1	39
<i>Ctenotus strauchii</i>	2	3	60
<i>Ctenotus tantillus</i>	0	1	5

quadrat in wet season, October-March, 1.5 per quadrat in dry season, April-September). During the warmest months, activity extends to dawn and dusk.

During this study, *C. rosarium* was found only in the extensive, uniform, gently undulating Cainozoic sand deposits along the Great Dividing Range (through the centre of the Desert Uplands). Specimens from Bede, Albionvale and Fortuna Stations were trapped predominantly within the low, open Yellowjack (*Eucalyptus similis*) woodlands with a moderate to dense spinifex (*Triodia pungens*) groundcover (regional ecosystem 10.5.1, Sattler & Williams, 1999; Fig. 6). Specimens were also captured at these localities in small patches of mixed *E. similis*, *Corymbia brachycarpa*, *Corymbia setosa*, *Corymbia dallachiana* woodlands (regional ecosystem 10.5.2, Sattler & Williams, 1999), interspersed and contiguous to the vegetation above. At White Mountains NP, specimens were trapped in open woodlands of *Corymbia leichhardtii*, *C. brachycarpa*, *Eucalyptus quadricostata* and *C. erythrophloia*, with a mixed *Triodia bitextura*/assorted tussock groundcover (regional ecosystem 10.5.9, Sattler & Williams, 1999). This vegetation type is associated, continuous and intergrading with the *E. similis*-dominated communities, and the floristic change reflects latitudinal, altitudinal and climatic gradients. Of the 196 quadrats examined, *C. rosarium* was trapped only in the above communities. A total of 63 individuals were trapped in 23 of 47 quadrats in the *E. similis* mosaics, while one individual was trapped in 5 quadrats sampled at White Mountains NP.

Table 2. Average scores for habitat variables with significant differences (Mann-Whitney-U test) between *C. rosarium* present and absent sites. Only significant variables are listed given the large number of variables examined (* = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$).

Habitat variable	Present	Absent	P
Foliage projective cover >10m	0.29	0.69	***
Foliage projective cover 1-3m	1.86	1.34	***
Forb cover (%)	3.05	6.64	***
Hummock grass cover (%)	40.24	11.26	***
Rock cover (%)	0.00	2.84	***
Sedge cover (%)	0.00	2.11	***
Tussock grass (%)	12.4	26.9	***
Rock cover 2-6cm (1=<2% to 6=75-100%)	0.00	0.31	***
Rock cover 0.6-2cm (1=<2% to 6=75-100%)	0.05	0.50	***
Soil type (1=sand to 5=clay)	1.14	2.79	***
Canopy height (m)	8.95	10.08	*
Number of species in ground strata	10.19	13.06	*

Analysis of environmental variables (Table 2) indicates that *C. rosarium* favours sites with less dense tree cover and height, and higher low shrub cover with ground stratum of low diversity including:- high hummock grass, low forb, sedge and tussock grass. The sandy soils are without rock.

Generalised linear modelling (Poisson error distribution) was undertaken to examine the effects of grazing and fire on a range of vertebrates within a small subset of *E. similis* quadrats (n=36) in the Desert Uplands bioregional survey (ASK unpublished data). Grazed areas are stocked at consistent rates due to moderate carrying capacities. Historically, due to Heat-leaf Poison Bush *Gastrolobium grandiflorum*, many paddocks in the region are ungrazed.

The minimum adequate model identified grazing as a significant factor (intercept -0.332, grazing 0.654, $p < 0.01$, total deviance explained 55%), with *C. rosarium* being less abundant in grazed sites (0.36/quadrat) than ungrazed sites (1.93/quadrat). Kruskal-Wallis analysis of variance by ranks indicated a significant change in some habitat variables (all $p < 0.001$) due to grazing (bare ground cover increase 39.3-53.2%, hummock grass cover decline 46.3-21.1%, tussock grass cover increase 5.4-13.2%) inferring a



FIG. 6. *Eucalyptus similis* habitat of *C. rosarium*, Fortuna Stn, 50km N Aramac (22°46'34"S 145°35'40"E) photograph by A.S. Kutt.

positive relationship between *C. rosarium* abundance and intermediate to high ground cover of hummock grasses. No significant fire effect was noted.

REPRODUCTION. QMJ72578 (SVL=40.6mm) and QMJ58560 (SVL=43.8mm) were dissected to determine that the larger individuals in the series were mature. Male QMJ72578 was in peak reproductive condition with testes enlarged and the epididymis opaque and turgid. It was collected mid December. A second male, QMJ58560, collected in early March, had a regressed testis and the epididymis, while still opaque, was flaccid. We did not attempt to assess minimum reproductive size.

DIET. The gut of QMJ58560 contained fragments of an ant (Hymenoptera, Formicidae, *Cerapachys* sp.) and one stinkbug nymph (Hemiptera, Pentatomoidea). QMJ72758 contained an adult weevil (Coleoptera, Curculionidae).

COMMENTS. In colour pattern, *C. rosarium* most closely resembles members of the *C. schomburgkii* species group (Storr, 1981; Storr et al., 1999) but it is precluded from this group by

the absence of mucronate keels on its subdigital lamellae. It could equally well be assigned to a number of other species groups, including the *C. lesueurii* or *C. leonhardii* groups. While we are not concerned with the placement of *C. rosarium* within the 'species-group' concept, we recognise these groups as units of convenience. Their validity as monophyletic assemblages is questionable (Pianka, pers. comm. 1996, preliminary phylogeny: <http://uts.cc.utexas.edu/~varanus/ctenotus.html>) and requires further study (Hutchinson & Donnellan, 1999; Aplin & Smith, 2001). The original diagnoses are loose and have not been redefined to accommodate new species. Placement of any species within the existing scheme is largely subjective.

Marked allopatry is seen between *C. rosarium* and *C. strauchii*, the only similarly-sized and patterned species in the Desert Uplands Bioregion, and there is partitioning between the habitat types in which they occur. *C. strauchii* was trapped in 12 regional ecosystems which consisted of low open acacia woodlands (*Acacia argyrodendron*, *A. harpophylla*, *A. cambagei*, *A. shirleyi*), riparian woodlands (*Eucalyptus camaldulensis*, *E. coolabah*), iron bark woodlands (*Eucalyptus whitei*, *E.*

melanophloia), heath, shrubland and sparse rocky woodland types. In some places the transition from one species to the other was sharp, particularly on the sandy soils where *E. whitei/melanophloia* dominated communities on yellow earths rapidly change into *E. similis* dominated communities on deep red sands. All records of *C. rosarium* are within *E. similis* and associated regional ecosystems on the deep red sands of the Alice Tableland. *C. strauchii* has been found in the neighbouring ironbark and other vegetation types, suggesting that regional ecosystem type may be a reasonable predictor for the distribution of both species.

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