

Figure 1. AGRRA survey sites in María la Gorda, Cuba. See Table 1 for site codes.

**RAPID ASSESSMENT OF CORAL COMMUNITIES OF MARÍA LA GORDA,
SOUTHEAST ENSENADA DE CORRIENTES, CUBA
(PART 1: STONY CORALS AND ALGAE)**

BY

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ABSTRACT

The Atlantic and Gulf Rapid Reef Assessment benthos protocols were utilized in four reefs off María la Gorda, western Cuba, in July 1999. Live stony coral cover ranged from 15.5-23.5%. *Montastraea annularis*, *M. franksi*, *Siderastrea siderea* and *M. faveolata* were the dominant species of stony corals. Large (≥ 25 cm diameter) stony corals were fairly abundant (7.5-10.5/10 m), but in two reefs had incurred moderately high values of recent partial-colony mortality ($\sim 10\%$). The major stressors on these stony corals were damselfish bites, damselfish algal gardens, diseases, and a relatively high abundance of fleshy macroalgae. Damselfish densities were probably elevated because their predators have been overharvested. Enforcement of existing fishing regulations and other management actions are necessary to preserve the ecological and touristic value of this reef system.

INTRODUCTION

The María la Gorda coral reef, considered one of the most beautiful, diverse and well-preserved of Cuban reefs, is located in a 1,216 km² Biosphere Reserve near the southeastern tip of Bahía (Ensenada) de Corrientes in the Península de Guanahacabibes (Fig. 1). The adjoining land is a karst plain covered by a naturally semideciduous, mesophytic forest that has been little disturbed although it is subjected to a restricted forestry. Annual rainfall averages 100-120 cm and mean air temperatures are 27-28° C in July and 20-22° C in January (IGEO-ICGC-ACC, 1989). Low rocky cliffs with coastal vegetation alternate with small sandy beaches along the coastline. No rivers empty into the bay.

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The only human settlement at María la Gorda is a small (29-room) dive resort with 50 associated dive sites. La Bajada, a tiny village located about 14 kilometers further north, has 22 houses, a frontier guard post, the Reserve's Visitors Center, and a meteorological radar station. Its human population totals less than 150 inhabitants.

The Guanahacabibes peninsula protects María la Gorda's leeward fringing reefs from the prevailing northeastern trade winds and from northerly cold fronts in winter. An irregular series of elongated low-relief (1-2 m) coral lobes (some forming spurs and grooves), each over ~100-200 m in length, about 50-100 m wide and oriented parallel to the shoreline, alternate with tongues of sand at depths of about 5 to 9-12 m on a gently sloping reef terrace. Small patch reefs border the lobes on their shallow and deep margins. However, the diving sites preferred by tourists are located in excess of 15 m on the reef slope where the reefs are aesthetically more beautiful, biologically more diverse, and have higher topographic relief.

Benthic reef condition was first assessed at María la Gorda within the framework of the *General assessment of the ecological state of the Cuban reefs and monitoring of the regional Cuban CARICOMP Station* and the Atlantic and Gulf Rapid Reef Assessment (AGRRA) initiative in July 1999.

METHODS

The benthic surveys were made by five divers in four reef lobes (one having well-developed spurs and grooves) that were considered representative of the reef terrace habitats in this strategically chosen tourist location. There were two "shallower" reefs in 5-6 m, and two "deeper" reefs that were located in 8 m and in 11 m, respectively.

Version 2.2 of the AGRRA benthos protocol (see Appendix One, this volume) was followed. We measured the sizes of "large" (≥ 25 cm diameter) stony corals (scleractinians and *Millepora* spp.) to the nearest 10 cm. *Favia fragum* and other species that are small as adults were not included in the counts of coral recruits. Sediment was removed from the algal quadrats before estimating the abundance of crustose coralline algae. Practice and consistency training occurred in reefs near Havana before the surveys were initiated. Our guide for coral identifications in the field was Humann (1993).

RESULTS

Stony Corals

Total live stony coral cover was somewhat higher in the two shallower reefs (20.5%, 23.5%) than in the two deeper reefs (15.5%, 17%), as was the density of large (≥ 25 cm diameter) corals (8.5 and 10.5/10 m versus 7.5/10 m, respectively; Table 1). In all four reefs, the large stony corals were dominated by *Montastraea annularis*, *M. franksi*, *Siderastrea siderea* and *M. faveolata* (Fig. 2A, B). The mean diameter of the large corals was about 50% greater in the two more southerly reefs (one each being shallower and deeper) than in the two more northerly reefs (60.5 and 63.5 cm versus 44

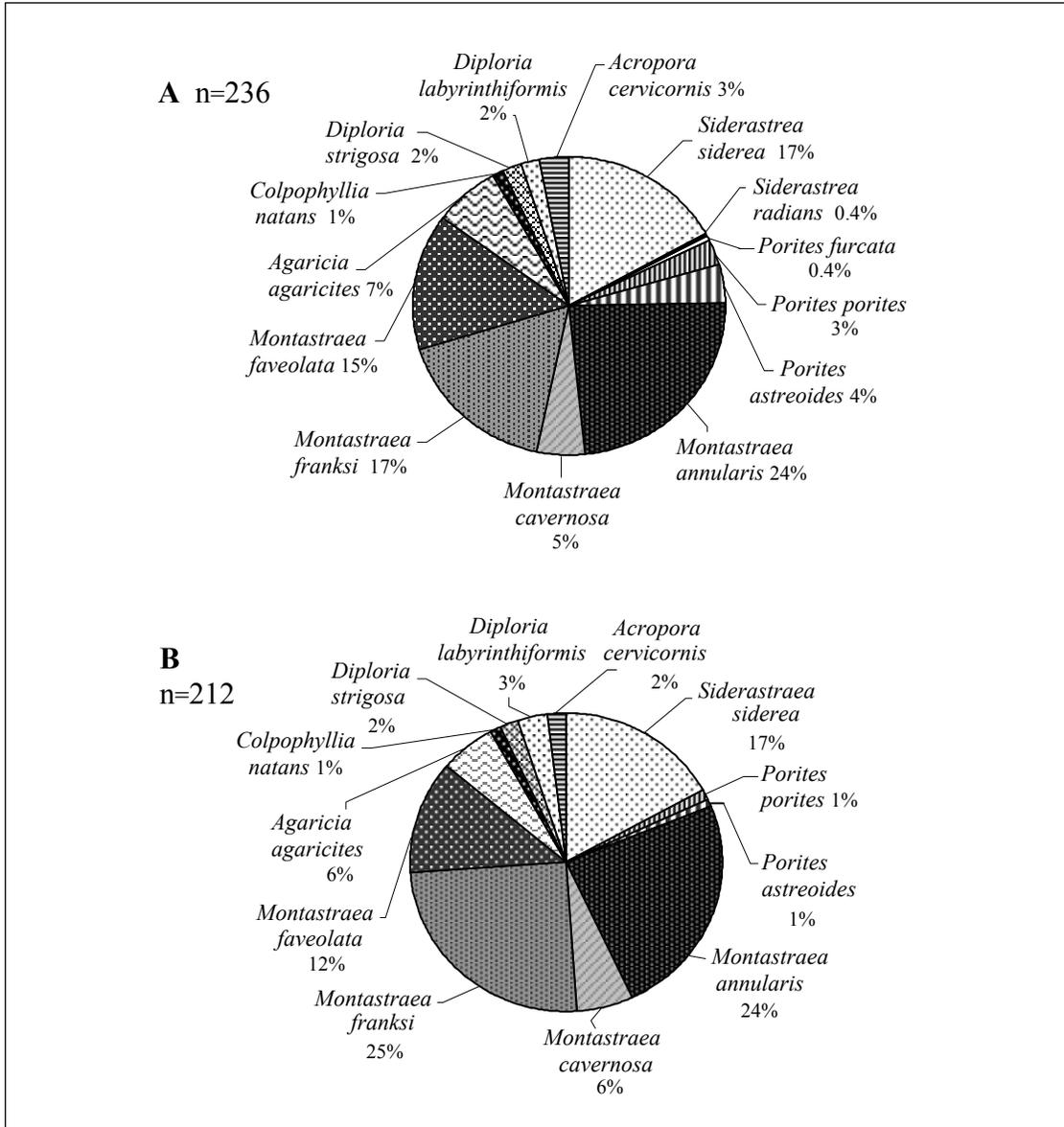


Figure 2. Species composition and mean relative abundance of the most abundant stony corals (≥ 25 cm diameter) at (A) 5-8 m, (B) 9-13 m in María la Gorda, Cuba.

and 46.5 cm, respectively). Overall, *M. faveolata* formed the largest colonies (to >300 cm in diameter) with no size class predominating, whereas most colonies of *M. franksi* and *M. annularis* were <70 cm in diameter, while few *S. siderea* exceeded 50 cm in diameter (Fig. 3).

Large stony corals in the two southerly reefs also had somewhat higher percentages of each of the following relative to the northerly reefs: recent partial-colony mortality (9 and 10.5% versus 3 and 5%); old partial-colony mortality (28.5 and 34.5% versus 24.5 and 27%); “standing dead” corals having 100% mortality on their upper

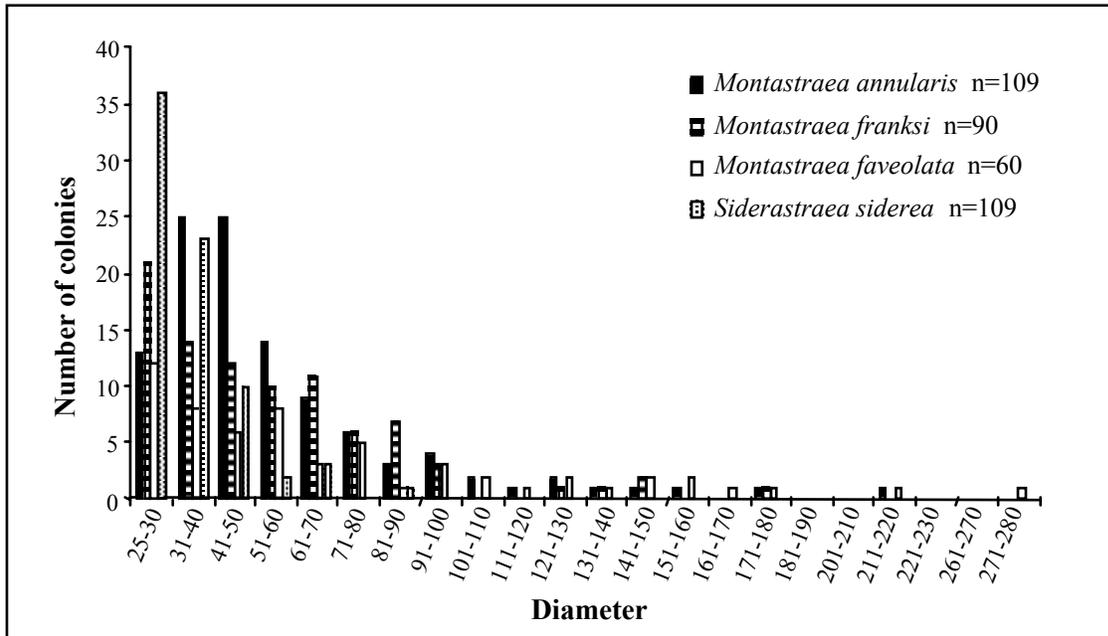


Figure 3. Size-frequency distribution in cm of colonies (≥ 25 cm diameter) of *Montastraea annularis*, *M. franksi*, *M. faveolata* and *Siderastraea siderea* at 5-13 m in María la Gorda, Cuba.

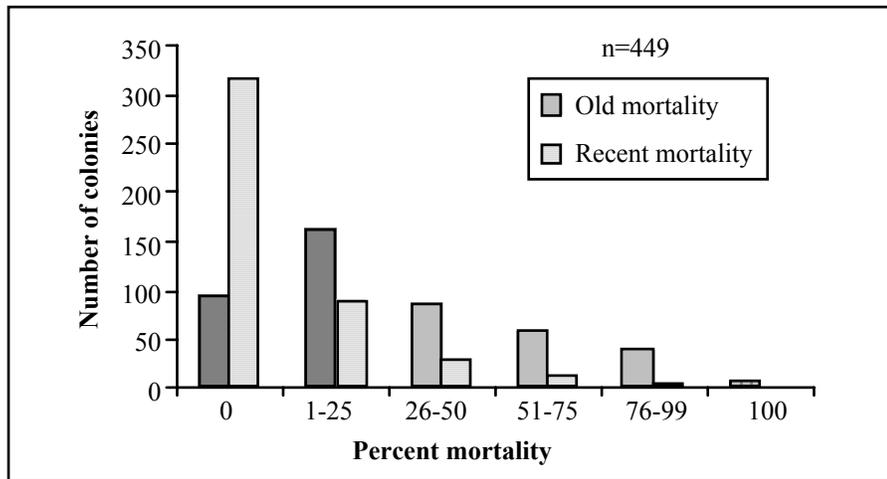


Figure 4. Number of colonies with old partial colony mortality and recent partial colony mortality for all stony corals ≥ 25 cm diameter at 5-13 m, in María la Gorda, Cuba.

colony surfaces and still in growth position (2 and 4.5% versus 1 and 1.5%); The percentage of stony corals that were bleached was also higher in the two southerly reefs (3.5 and 5.5% versus 1 and 2%, respectively; Table 2). Nevertheless, the majority of these colonies had no recently dead tissues (Fig. 4).

An average of 3-6.5% of the large stony corals in each reef showed signs of disease. Most commonly noted were white-plague disease in *M. annularis*, *M. faveolata* and *M. franksi*, black-band disease in *Diploria strigosa*, white-band disease in *Acropora cervicornis*, and dark spots disease in *S. siderea*. In addition, some unusually darkly pigmented tissues were seen in *Agaricia agaricites* (two colonies) and *Colpophyllia natans* (one colony). The species that were either pale or partially bleached were *S. siderea*, *M. annularis*, *M. franksi*, *M. faveolata* and *P. astreoides*. Colonies of *S. siderea*, *M. faveolata*, *M. franksi* and *M. annularis* were found with deep parrotfish bites, while damselfish and their algal gardens were particularly common in *D. strigosa* and *D. labyrinthiformis*.

The density of stony coral recruits varied from 0.1-0.2/0625m² (Table 3) which is equivalent to 1.6-3.2 /m². *Siderastrea siderea*, *Porites porites* and *P. astreoides* dominated this assemblage (Fig. 5).

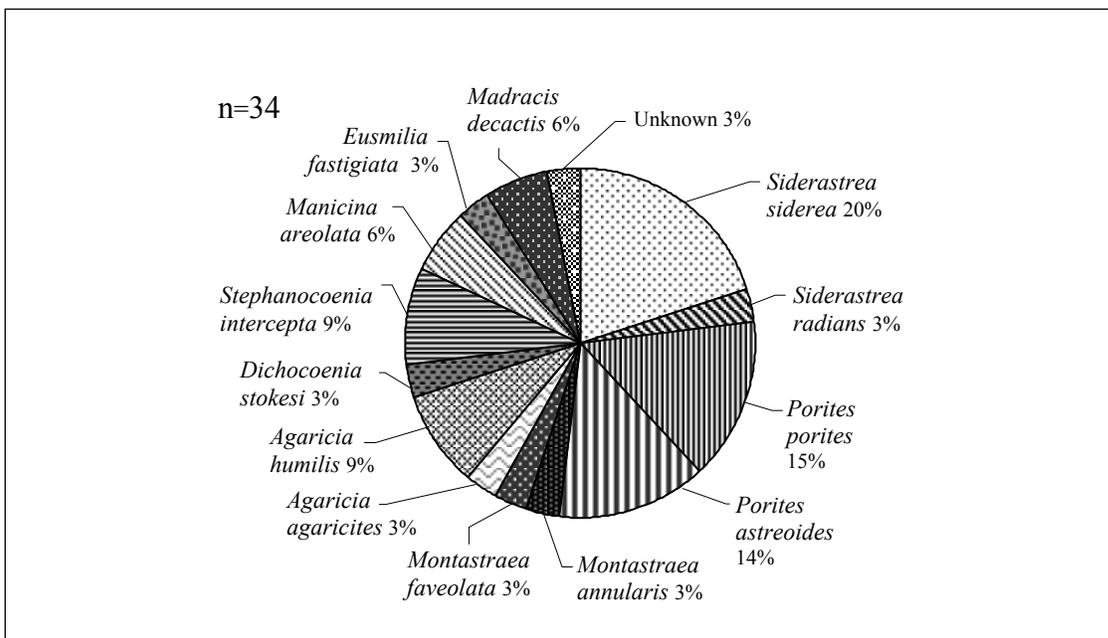


Figure 5. Species composition and mean relative abundance of all stony coral recruits (≤ 2 cm diameter) at 5-13 m, in María la Gorda, Cuba.

Algae and *Diadema antillarum*

In terms of relative abundance, macroalgae were the predominant algal functional group (46-60%) in all four reefs, with crustose coralline algae being the least abundant (13-18%; Table 3). Macroalgae were dominated by *Dictyota divaricata*, *Lobophora variegata* and *Sargassum hystrix* whereas green calcareous algae were scarce. Mean macroalgal heights were 2-2.5 cm, and macroalgal indices (relative abundance macroalgae x mean macroalgal height) ranged from 97 to 150. Densities of *Diadema antillarum* varied from zero to 4.3/100 m² (Table 3).

DISCUSSION

María La Gorda is the first Cuban coral reef to have been assessed by the AGRRA protocols. The prevalence of the *Montastraea annularis* species complex in all four reefs is an indication that this reef is generally in good condition. The relatively limited abundance of the sediment-tolerant *Siderastrea siderea* (Fig. 2) is suggestive that sedimentation is a less severe stress than in many other Cuban reefs e.g., at Archipélagos Sabana-Camaguey, Cayo Diego Pérez, Cayo Cantiles and Cayo Juan García (Alcolado in prep.), Cayo Largo (Alcolado et al., 2001), and Ciudad Habana (Herrera-Morena and Alcolado, 1983; Alcolado and Herrera-Moreno, 1987). *Siderastrea siderea* was, however, more common in the deeper reefs where sediment deposition rates may be somewhat higher due to reduced wave energy.

Although relatively few stony corals were still affected at the time of our survey in July 1999, the populations at María la Gorda had undergone severe bleaching during the 1997-98 El Niño warming event (C. Carrodegua and N. Capetillo, personal communication). The relatively high estimates of recent partial-colony mortality found in the two more southerly reefs (Table 2) may, in part, represent post bleaching-related mortality and, in part, the effects of diseases that were on-going in summer 1999. Overall estimates of recent partial-colony mortality (3-10.5%) at María la Gorda varied from low to moderately high by comparison with results obtained in earlier AGRRA surveys (Kramer and Kramer, 1999; Lang, 1999; Leão et al., 1999; Steneck and Lang, 1999). Similarly, the mean percentages of old mortality (<35%) can be considered moderate.

Damselfish bites (primarily due to *Stegastes planifrons*) and their algal gardens, a suite of coral diseases, and fleshy macroalgae were the most common stressors of the large stony corals at María La Gorda. Injuries inflicted by the damselfish could also have facilitated the spread of coral diseases. The positive relationship between colony diameter and impacts (partial-colony mortality, percent of stony corals with disease and damselfish algal gardens) at the two southerly reefs suggests a gradual process of accumulation of partial-colony death as size (and, to some extent, age) increases.

The somewhat elevated densities of *S. planifrons* presumably resulted from a local deficit of carnivorous fishes (Claro and Cantelar Ramos, this volume). The high relative abundance of fleshy macroalgae (and perhaps the scarcity of calcareous macroalgae, Hay, 1997) is probably a response to the continued scarcity of the key herbivore, *Diadema antillarum* (Table 3), and to low herbivory by fishes (Claro and Cantelar Ramos, this volume). Hence, to sustain the María la Gorda coral reefs, the following management actions will be necessary:

- Avoid the construction of hotels and other major tourism infrastructure within the coastal zone of the reserve.
- Strictly prohibit all illegal fishing in the Península de Guanahacabibes Biosphere Reserve, allowing stocks of reef fishes to recover. (Partial enforcement of fishery regulations is ineffective, Watson et al., 1997.)

- Avoid nutrification (Alcolado et al., Instituto de Oceanología unpublished report) of the coastal waters. Currently the resort's wastewaters are poured into excavations in the karst and probably leak into the sea via groundwater. Thus, an alternate disposal system will be required.
- Deploy permanent mooring bouys at all dive sites.
- Ensure the resort divers are educated in safe reef-diving etiquette, and that the carrying capacity of the reefs (Hawkins and Roberts, 1997) is not exceeded.

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Table 1. Site information for AGRRA stony coral and algae surveys in María la Gorda, Cuba.

| Site name | Site code* | Reef type | Lat.itude (° ') | Longitude (° ') | Survey dates | Depth (m) | Benthic transects (#) | ≥25 cm stony corals (#/10 m) | % live stony coral cover (mean ± sd) |
|-------------------------|------------|---------------|---------------------|---------------------|----------------|--------------|-----------------------------|------------------------------------|--|
| Yemayá | MG-Sh-1 | Fringing lobe | 21 50.059 | 84 29.390 | July 8-9 1999 | 5-6 | 12 | 10.5 | 23.5 ± 4.5 |
| Acuario | MG-Sh-2 | Fringing lobe | 21 47.644 | 84 30.733 | July 6-7 1999 | 5-6 | 13 | 8.5 | 20.5 ± 5.5 |
| Jardín de las Gorgonias | MG-D-1 | Fringing spur | 21 48.566 | 84 30.823 | July 8-10 1999 | 8 | 14 | 7.5 | 17.0 ± 4.0 |
| La Cadena Misteriosa | MG-D-2 | Fringing spur | 21 47.270 | 84 31.094 | July 6-8 1999 | 11 | 15 | 7.5 | 15.5 ± 3.0 |

* MG = María la Gorda; Sh = shallower; D = deeper

Table 2. Size and condition (mean ± standard deviation) of all stony corals (>25 cm diameter), by site in María la Gorda, Cuba.

| Site name | Stony corals | | Partial-colony mortality (%) | | | Stony corals (%) | | |
|-------------------------|--------------|---------------|------------------------------|-------------|-------------|------------------|----------|----------|
| | (#) | Diameter (cm) | Recent | Old | Total | Standing dead | Bleached | Diseased |
| Yemayá | 128 | 46.5 ± 23.5 | 3 ± 9 | 24.5 ± 27 | 27.5 ± 27.5 | 1.5 | 1 | 3 |
| Acuario | 108 | 60.5 ± 46 | 9 ± 18 | 28.5 ± 28.5 | 37.5 ± 29.5 | 2 | 5.5 | 6.5 |
| Jardín de las Gorgonias | 106 | 44 ± 19 | 5 ± 12 | 27 ± 28 | 33.5 ± 27.4 | 1 | 2 | 4 |
| La Cadena Misteriosa | 110 | 63.5 ± 37 | 10.5 ± 19 | 34.5 ± 32 | 45.0 ± 31.1 | 4.5 | 3.5 | 4.5 |

Table 3. Algal characteristics (mean ± standard deviation), abundance of stony coral recruits and *Diadema antillarum*, by site in María la Gorda, Cuba.

| Site name | Quadrats (#) | Relative abundance (%) | | | Macroalgal | | Recruits (#/0.0625m ²) | <i>Diadema</i> (#/100 m ²) |
|-------------------------|-----------------|------------------------|------------|-----------------------------|-------------|--------|---------------------------------------|---|
| | | Macroalgae | Turf algae | Crustose coralline algae | Height (cm) | Index* | | |
| Yemayá | 60 | 46 ± 20 | 37 ± 20 | 16 ± 12 | 2.1 ± 0.8 | 97 | 0.12 | 0 |
| Acuario | 60 | 55 ± 20 | 32 ± 21 | 13 ± 11 | 2.0 ± 0.8 | 110 | 0.10 | 0.8 |
| Jardín de las Gorgonias | 60 | 60 ± 18 | 25 ± 15 | 15 ± 11 | 2.5 ± 1.0 | 150 | 0.20 | 4.3 |
| La Misteriosa | 50 | 47 ± 24 | 35 ± 22 | 18 ± 17 | 2.4 ± 3.4 | 113 | 0.16 | 2 |

*Macroalgal index = relative macroalgal abundance x macroalgal height