be dealt with quickly. This is especially true in a situation where a mower has broken down. Portable welders, compressors, batteries and tools can be transported to the site within minutes. The same applies to pumps, irrigation equipment and generators. From this it can be seen how versatile this type of vehicle can be when used to its full capacity.

ATVs fall into two categories - the single person unit or the type that has the facility to carry more than one person plus equipment. There is a wide choice of models with or without cargo beds and engines come in all sizes including diesel-powered units. To get the necessary traction, not all models have a differential, so this tends to make turning circles fairly large if the possibility of damaging turf is to be avoided. It is worth checking out if the particular model you are interested in has a differential; especially if it is likely to be used in confined areas.

Two applications where the ATV has proved to be highly successful are spraying and fertiliser distribution. Because of their design the units can often go on turf when other machinery would mark or damage it.

Since their introduction, a whole range of attachments including sweepers, and trailers have been developed specifically for them, so there are a wide range of jobs they can be adapted to carry out.

As stated before, getting an ATV through committee might be difficult. For this reason it is important to gather as much information as possible. Talk to your local suppliers; ask them to give details of other courses where the vehicles are being used. Contact these and find out their views. Gather as many facts and figures as possible on running costs, time saved and any other details that help to make a good case.

ATV's have not always enjoyed good press coverage - as a result people have become very sceptical; so you need to have answers to overcome their objections.

The fact that an ATV is designed to travel over relatively hostile terrain means that over confidence sets in and the vehicle may be pushed beyond its limits. The resulting accident becomes headline news. In this situation the question needs to be asked, "Was the unit being driven safely and within its limitations?" All machinery used on any golf course is dangerous if used incorrectly.

Looking at the overall introduction and development of machinery usage on golf courses over the years, the ATV after just two decades is still very much in its infancy. There is a good case for its introduction into a fleet as a highly mobile greens, tees and bunkers servicing unit.

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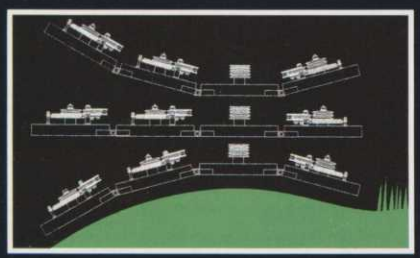

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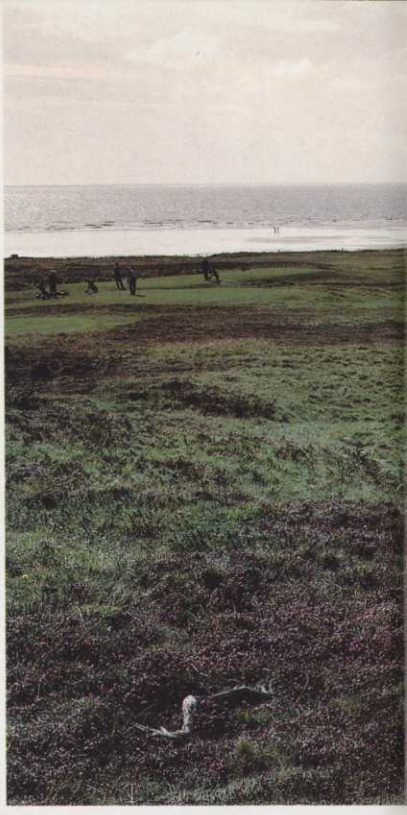
AD REF 501

Michael Bird discovers a course where the weather is less than kind when he pays a visit to Royal Porthcawl...

Braving the elements

Recognised as one of the finest links courses in the British Isles, Royal Porthcawl Golf Club's location on the South Wales coast places it in the front line of a virtually continuous battle against the elements.

Braving the elements



Founded in 1891, the club has hosted many notable tournaments during its distinguished 107 year history.

These include the Amateur Championship, held five times between 1951 and 1988, the Home Internationals, British Boys' Championship, Dunlop Masters and Coral Welsh Classic.

However, it was the preparations for the club's centenary year in 1991 and the Walker Cup in 1995 which posed probably the greatest challenge on the links, triggering a series of events which have occupied Course Manager, David Ward, and his greenkeeping team for the whole of the present decade.

"The course is laid out on a coast which faces directly into the prevailing south-westerly winds," commented David.

"As a result, course management decisions and actions are influenced greatly by the weather and the sea. The close proximity of the shoreline means that we are under constant threat of flooding. At the same time, the wind is continually drying and eroding the natural dunes and grasses.

"Our rainfall is also well below the average for Wales. Instead of dropping their contents as they cross the coast, the storm clouds that sweep in from the Atlantic tend to wait until they reach the Welsh mountains. Average yearly rainfall in Brecon, 40 miles away, is four times that of Porthcawl."

Above: David Ward, Head Greenkeeper at Royal Porthcawl GC

Below: The greenkeeping team at Royal Porthcawl GC

These annually recurring problems were exacerbated by the exceptionally dry years during the late 1980s. So, when David was appointed Head Greenkeeper in August 1990, his immediate task was to restore a parched course to the best possible condition for the club's forthcoming centenary year. At the same time, he put in place a five year plan to renovate and improve the course ready for the Walker Cup in 1995.

"Although it was evident that the irrigation system needed upgrading and extending beyond solely the tees and greens, this was not my only concern," David pointed out.

"Over the years, conditions had taken their toll on the whole course and there was pressing work to do on the greens, tees, bunkers and rough.

Improvements were also required to the sea defences and drainage, principally alongside and on the second and third fairways. During the winter storms of 1990, we suffered salt water flooding to a depth of 12 feet on the 3rd fairway, which played havoc with grass growth and soil conditions."

The programme instigated by David in the autumn of 1990 commenced with intensive hollow coring and sand top dressing of all the greens to eliminate the thatch that had become established. The treatment was accompanied by a scarifying action followed by overseeding with a fescue/bents mix.

"The response was excellent and we have continued to verti-drain, hollow core, top dress and overseed every year since," said David.

"Nothing fancy, simply regular treatment during the late summer and autumn applying plenty of sand which is brushed mechanically into the core holes."

To assist the renovation of the greens, work began on upgrading the adjacent sprinkler heads to provide better and more even distribution of irrigation water.

The essential works carried out during late 1990 and early 1991 by David and his staff ensured that Royal Porthcawl's centenary year is remembered for the right reasons by club members and the many visitors from Britain and overseas who played the course during 1991.

However, there was plenty still to do to get the course ready for the Walker Cup four years ahead.

Working in conjunction with the greens committee and specialists appointed by the R&A, David started on a programme of rebuilding tees and bunkers, renovating fairways and controlling bracken in the rougher areas.

Between 1992 and 1994, every one of the 96 bunkers on the course received some attention, ranging from complete revetting of the front and sides to the installation of drainage systems and bunker sand renewal.

A particular problem had been created by the use of fine dune sand which had become compacted over the years by feet and rain, restricting the free downward movement of water. As well as laying pipe drains and constructing drainage sumps in many of the bunkers, the club decided to replace the dune sand with locally dredged sand from the Bristol Channel.

Slightly coarser than the original, it provides the stroke-making characteristics of a good bunker sand, yet drains freely and does not blow so easily.

At the same time, around half of the tees on the course were either being rebuilt and returfed, or renovated using a similar aerating, top dressing and overseeding programme to that employed for the greens.

To improve drainage and grass growth, regular verti-draining and slit or spoon tining was introduced for the fairways. These treatments were accompanied by application of a green mulch compost to the thinner areas to add body and reduce erosion, encouraging re-establishment of the native bents and fescue grasses.

With the co-operation of Mid Glamorgan County Council, a formidable barricade of huge boulders and shingle banking was placed along the foreshore in strategic positions between the first tee and third green. This has since been complemented by a soil and sand flood

bunding on the course to protect the low-lying parts of the third fairway.

"The course was in pretty good all-round condition as the Walker Cup approached," commented David.

"However, 1995 was a very dry and difficult year, highlighting the urgent need for controlled irrigation across the whole course. Although we fared better than many other clubs, the fairways and tees suffered badly prior to and during the tournament."

The decision was taken to carry out a complete upgrade of the irrigation system over the next three years, with completion of the main work planned in good time for the Home Internationals being held at Royal Porthcawl this September.

As most of the greens' pop-up sprinklers had been renewed between 1990 and 1995, top priority was given to laying new pipework and providing new sprinklers for the tees. There was also an urgent need to improve the storage capacity and the quality of the water being applied, as David explained:

"Prior to the Walker Cup, we had relied on two 12,000 gallon tanks supplied by a bore hole on the course," he said.

"To prevent the irrigation pumps running dry, a control system had been installed which switched off the water long before the tanks were empty, giving us a total available capacity closer to 16,000 gallons. It was clear that this was a long way short of the actual requirement which would be needed for watering all the greens, tees and fairways.

The second problem was the quality of the water being pumped onto the course. Because the borehole is only 170 yards from the beach, the water had always been slightly brackish. However, it was analysed monthly and had not caused any real concerns until the drought of 1995. Measured a week or two before the Walker Cup, the sodium level had risen from a normal reading of 200 milligrammes per litre to almost 600 milligrammes per litre, causing tremendous stress to the grass."

To overcome the water supply difficulties, David arranged for the installation of a new above-ground butyl-lined store with a total capacity of 63,000 gallons. Water is supplied from the bore hole via a smaller capacity pump with a lower extraction rate. Although taking longer to fill the store, sodium and calcium concentrations are reduced.

As a safeguard in drier periods, the club also budgeted £7,000 a year for a mains water feed to the store. A conductivity monitor constantly measures the chemical composition of the water supply from the bore hole, turning it off the moment salt concentrations rise above a pre-set level. The mains water feed is then switched on, automatically, to replenish the store until the bore hole monitor allows the flow of water from below ground to be restored.

A second conductivity monitor fitted within the pipe between the store and the pumps ensures that calcium or sodium concentrations in the irrigation water never approach danger levels. As a result, water quality and quantity are now of a consistently high standard.

Maximum water usage on the course over 24 hours has been estimated at 35,000 gallons, although David said this was a worst case situation in the most trying of conditions.

"However, we can refill the new store from empty in 15 hours and can still call on the two existing 12,000 gallon tanks if needed.

The new store and pumps feed a pair of water pipes running out to two different parts of the course to supply the various sprinkler heads," he explained.

"We have two small jockey pumps to maintain an equal and

Braving the elements

consistent pressure in the system. If needed, a third pump kicks in. We also have a fourth pump in the shed ready for the day that the irrigation system covers the whole course, including all of the fairways."

The complete Watermation system is controlled by an automatic timer in David's office. It also has a remote control unit enabling individual sprinkler heads to be stopped and started from out on the course.

Having reached a position from which he can exercise precise control over the fresh water being pumped onto Royal Porthcawl's turf, David is now looking to achieve a similar status with sea water and drainage run-off.

A new green has been built on a higher-lying area behind the existing second green to minimise the risk of flooding, with the adjacent dune system providing additional protection against stones or water being blown from the beach. Currently growing in, the new green will be assessed by members this season.

The 3rd fairway, notorious for flooding from both the sea and the surrounding higher ground, now features a 1,000 gallon underground collection chamber with pump. All water finding its way into the chamber is quickly pumped out to sea.

"The course will be all the better for the improvements being made," concluded David.

"Although we are situated in a very harsh environment, it is most important to work with the elements. After all, it is the weather and location which give Royal Porthcawl its truly great character."

Dr. Stephen Baker and Daniel Binns of the STRI, give an insight into the results of the questionnaire which was completed by greenkeepers last year on the earthworm problem

Opening a can of worms

The cost to UK golf courses per year due to earthworms...

£2m

Moderate to serious earthworm cast problems on fairways...

49%

Moderate to serious earthworm cast problems on tees...

42%

Opening a can of worms

When the use of chlordane was revoked in December 1992, we anticipated that the problems of earthworm casting on golf courses would increase substantially because of the withdrawal of this effective (but environmentally unacceptable) form of chemical control. Fortunately, R&A also recognised that extensive casting would have substantial effects on the quality of golf courses (a problem that had bedevilled greenkeepers in the first part of this century) and were prepared to fund an extensive programme of research at the STRI to examine alternative strategies for earthworm control. This is the first of a number of articles that we plan to publish in Greenkeeper International this year detailing some of the main findings so far from this work. This month we intend to examine the severity of earthworm casting and to consider some of the factors associated with high rates of casting activity.

How bad is the problem of casting?

Problems associated with casting are easy to list; surface smearing, unevenness, water retention, slipperiness and weed invasion. It is perhaps more difficult to get information of the severity of the problem, so this was the subject of a questionnaire survey sent to golf clubs in April 1997 to coincide with the end of the main period of casting activity. In total, 297 clubs (nearly always the Head Greenkeeper or Course Manager) kindly completed a very detailed questionnaire.

The first main message from the results was indeed that there was a major problem with casting on UK golf courses and, more importantly, the problem was increasing. The situation was worst on tees and fairways. Of the questionnaire returns 49% indicated moderate to severe problems on fairways and for tees the corresponding figure was 42%. Casting was lower on greens and only 9% of clubs indicated moderate to severe problems on the putting surface.

In the period shortly before the use of chlordane was banned, many courses were treated with this persistent organochlorine compound and this undoubtedly had residual effects. This was coupled with the fact that both 1995 and 1996 were abnormally dry years which probably affected earthworm populations and certainly reduced the amount of casting activity. However by April 1997 when the questionnaire was sent out, nearly two-thirds of respondents suggested that rates of casting had increased compared with the period before December 1992 when chlordane was available and 22% of responses suggested that casting was a much greater problem. The autumn and winter of 1997/98 were very wet and, judging from visits to courses during this period to monitor earthworm activity, we suspect that had the questionnaire been sent out a year later the number of courses reporting severe problems would have been substantially higher.

In 1996 the average expenditure by a golf club on pesticides for earthworm control was estimated to be £525 and 14% of clubs were spending more than £1000 per year on pesticides. When the costs of labour and spraying equipment are also included, the humble earthworm must cost UK golf courses well over £2 million per year and this figure appears to be increasing.

Environmental factors influencing earthworm casting activity

The questionnaire returns also provided useful information on soil and management factors that may influence earthworm populations and casting activity. Course type had a major influence on earthworm casting and, for example, Fig. 1 shows that for fairways far more problems were reported on converted agricultural land and parkland courses than on links courses. The effects of casting was also greater on heavier soils but, perhaps surprisingly, the relationship between casting activity and acidity was not statistically significant.

On many courses casting activity was greater on certain holes and the main reasons for this, listed in order of the number of responses in the questionnaire data, were higher moisture contents (poor drainage), heavier soils, imported topsoil or turf, higher pH/lime application and low-lying areas.

These relationships were examined in much more detail in the second phase of the work which consisted of visits to 32 golf clubs to carry out detailed measurement of soil factors that might be related to earthworm activity.

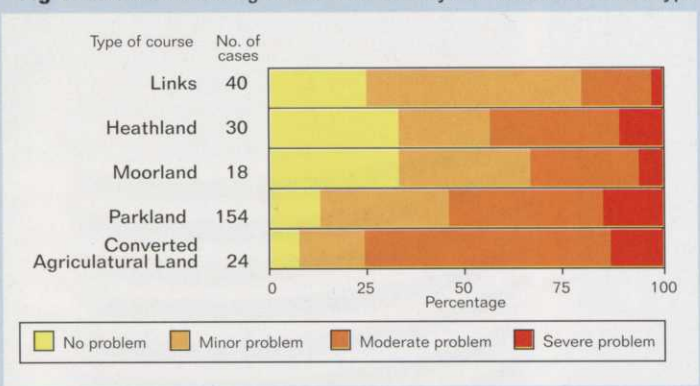
Earthworm Ecology Survey

In response to the questionnaire survey, 32 golf courses were targeted to assess the severity of casting activity and factors influencing earthworm populations. Due to ease of access from STRI Headquarters in Bingley, 19 of these courses were located in northern England, five in southern England and the Midlands, six in Scotland and two in Wales. By analysing soil samples for texture, pH and compaction and most importantly identifying the species of earthworms present, our aim has been to gain a greater understanding of the biology of earthworm populations. This in turn will help to target earthworm control strategies in the future.

In most cases data was collected from two fairways on each course, one an area of high casting activity and the other area selected was usually the second fairway.

Soil physical measurements

Fig 1: Earthworm casting on tees and fairways in relation to course type



included a full particle size analysis, soil pH, organic matter content, thatch depth, bulk density (an indication of soil compaction) and moisture content. Most of these measurements were taken at more than one depth between 0-300 mm which helps us understand the variations in soil profile.

Measurements of earthworm activity included the number of earthworm casts per square metre and a measurement of the mean dry weight of soil per earthworm cast. The number of earthworms per square metre was also measured using an expellant method.

For a golf course to be included in the table shown below, there had to be a difference of 50% between fairways when counting the number of casts per square metre. This allows us to analyse data taken on different days in different conditions in a more controlled manner and more importantly it allows us to compare the differences between an area of high earthworm activity and one of "normal" activity. Data from areas treated with worm killers in the last three months were not used during analysis.

From the table on the right, we can see that a number of factors significantly affect earthworm casting rates. First of all, obvious though it may seem... the more earthworms that are found in the ground (in this case expelled to the surface), the greater the amount of casting. Also as casting increases, so does the size of cast.

However, the results also show that casting activity is greatest in areas of high soil pH, high soil moisture content and where grass growth is, for a variety of possible reasons (e.g. moisture or fertility), more vigorous.

Relationships with organic matter content are interesting and casting is highest in areas of low organic matter content. In some respects, higher populations may be associated with more organic matter as this would give a greater food supply. However, it is likely that the higher organic matter contents and increased thatch depth in the areas with less casting activity result from lower rates of organic matter breakdown. This could be related to more acid soils, drier soils and the lack of earthworm activity which is an important first stage in the decomposition of organic material.

The results of this survey work have shown that many soil factors can affect earthworm populations and casting activity. This has many implications in the way we might manage golf courses to minimise casting activity with reduced pesticide application. This will be examined in a further article in the autumn and we also intend to provide an update on work based on chemical control methods examining the effectiveness of different materials as an alternative to chlordane.

	High casting fairway	Normal fairway
Number of earthworms expelled/m^2	54	24*
Mean cast weight (g)	1.1	0.7*
pH (50-130mm)	5.5	5.0*
pH (130-300mm)	5.8	5.2*
Volumetric moisture content (50-130mm) (%)	36.3	30.4*
Bulk density (g cm^3)	1.28	1.27
Organic matter content (0-50mm) (%)	17.2	28.8*
Organic matter content (0-300mm) (%)	10.4	15.0*
Thatch depth (mm)	8.6	13.3*
Vigour of grass growth (1-10 scale, 10=highest)	7.1	6.4*
Sand content (%)	54	50
Silt content (%)	27	30
Clay content (%)	19	20

* Statistically significant

Differences in soil physical properties for areas of high casting activity and more normal conditions

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