Cycle®

MARCH 1976 75 CENTS

YAMAHA'S AIR-FORK MONOSHOCK YZ400C

HONDA 550 SUSPENSION TUNE

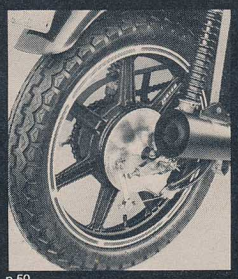
TOUR-A-MATIC MOTO GUZZI TWIN

HATE AND LOVE: LAVERDA 1000cc TRIPLE

Cycle®

March 1976 Volume XXVII No. 3

p.28



p.50

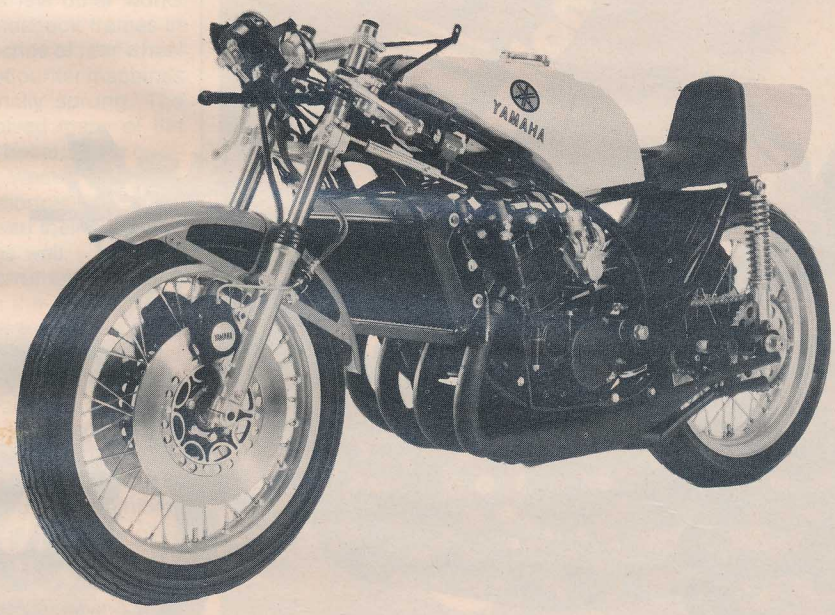
p.36

p.75

This Month's Cover: Those lumps on top of the fork legs don't look like much, but they represent technology that may revolutionize motorcycle front suspension. Variable spring rates out of an air hose, after all, can't be all bad. Photography by Dale ("the Poor Man's Steichen") Boller.

DAYTONA PREVIEW

YAMAHA'S ANNUAL BEACH PARTY



With Suzuki on the sidelines waiting to see how the rules develop and the 750 Kawasakis in the hands of privateers, Yamaha should have its easiest Daytona 200 yet—if it can keep itself from falling asleep. By Kevin Cameron

● A colorful and fascinating ten years of factory road racing in the US is ending at last. Suzuki has quit completely, Kawasaki has turned its equipment over to the privateers and Yamaha has released all its riders but Ken Roberts. In Europe, after several debilitating seasons of heavy spending, the Japanese companies are pausing, leaving the field to the privateers and to ambitious small firms like MV and Morbidelli.

This apparent slow-down is coming at a very novel and exciting period of machine development when suspension and handling are at last receiving more attention than horsepower. Radical departures here are long overdue, but racing has rewarded the safe bettors, the people who keep the power increases coming and fiddle with the other bits enough to get by. The innovator, putting his resources into new concepts, finds himself without the means to buy pistons. The guy with the pistons wins.

The 750 performance envelope includes a wide range of speeds and cornering angles in which engine power is enough to knock the machine down or flip it over backwards. The winning rider is the one who can closest approach these limits—but any instability at the limit will bring disaster. The traditional motorcycle generates such instability inherently. Forces are led into the frame at three points, too concentrated for any but the heaviest structure to properly resist. Suspension parts are called upon to do too many things at once. The front fork, for example, must move freely even when subjected to the massive sideload of heavy braking. The wheel acts at ground level, but its forces are reacted into the frame thirty inches away. This huge leverage requires a heavy steering head, or frame deflection will result.

The swing arm, at the back, is subject to at least eight different forces, positive and negative, arising from the operation of the brakes, the engine, and the suspension. These must be absorbed somewhere in the suspension's travel or they will slam the shocks completely open or shut. Such suspension bottoming is a principal cause of "wheel chatter," with shock loads transmitted directly into the frame, bending it like a powerful spring. As it springs back, the frame excites coupled oscillations between the gyroscopic torques of the spinning wheels. A very stiff frame couples front and rear wheels so tightly that such wobbles are damped out, but a limber frame can allow them to build up, in some cases to levels at which control is lost.

This proneness to oscillation is the biggest single factor inhibiting motorcycle chassis progress. By contrast, a car is heavily damped around its three axes of rotation; pitch, roll, and yaw. The motorcycle's apparent freedom around the roll axis is complicated by being coupled with gyroscopic torques and chassis flex: the motorcycle's special problem.

This unique behavior for years has made the motorcycle resistant to the methodical, scientific approach that has made today's GP race car what it is. The successful motorcycle chassis tuner is often more artist than engineer, playing the spring rates, damping oil, ride height and the like to achieve limited stability on a given race course. The 750 racer's special problems, arising from weight and power, have forced construction of stronger frames, which in turn have peeled away layers of traditional problems, revealing at last the possible benefits of low unsprung weight, new suspension geometry, and longer wheel travel.

Just as front brake force requires long front suspension travel to avoid bottoming, engine power has now worked the same equation at the back, and the motocross innovation of long travel rear suspension has been added to today's road racer. Compelled by these circumstances, the major companies are willing now to consider rational thought rather than tradition as a tool in suspension design. Tradition dies hard, but riders want to live, too.

Kawasaki's four-bar linkage rear suspension is truly a break with the past, for it relieves the swing arm of one of its jobs: resisting the squatting force generated by the tension in the drive chain during acceleration. With the parallelogram the designer is able to place the swing arm pivot right on, or even above the chain line, so that chain force is either zero, or actually subtracted from other forces to jack up the back end under acceleration. This is promising because long travel, with its large dive under braking, is not needed to achieve freedom from bottoming. For the future, at least two companies are working with hub steering as an answer to the problems at the front; i.e., excessive stress concentrations, high structure weight, side-load binding and dive under braking.

Once the barrier to such thought is pierced, the innovations come quickly. But now the big companies are withdrawing, and the racing engineers are being returned to more mundane work. It's too bad.

What about the future? Suspension and handling is the hot area in racing, but the makers race ostensibly to boost sales. If air pollution standards force them to sell only four-strokes, they will race only four-strokes.

Even the auto makers are having trouble meeting emissions standards, and are considering junking out the entire Otto cycle concept and beginning again with something better. Ultimate power is no longer valued in vehicle design as much as efficient use of fuel. Reflecting this trend, the FIM plans to impose a mandatory yearly reduction in fuel consumption for the heavy racing classes. If racing is to break new ground for the industry, then this is the proper basis for future rules-making. Classes based on displacement, which stresses ultimate power per cubic inch, may now be an anachronism. Harley-Davidson's 1973 suggestion may have been prophetic, proposing to issue each machine with the same potential total fuel energy for the race distance.

Four-strokes are heavy, but they use little fuel—about .5 pound per brake horsepower per hour. Their CO and unburned hydrocarbons (UHC) emissions are low, but racing engines, with their high compression ratios, make lots of NOX.

Two-strokes dominate racing because their specific power is very high and their weight and complexity are low. They are wasteful and polluting devices, however, using between .7 and 1.0 pounds of fuel per horsepower per hour, and releasing gross amounts of unburned hydrocarbons. Their CO is comparatively low, and their NOX, because of exhaust gas contamination, is very low.

Ford Motor Company commissioned a study of possible replacements for the Otto Cycle, bypassing the whole question of two-stroke vs. four, piston vs. Wankel. This study recommended further development of the Brayton, or gas turbine cycle, and the Stirling, or hot air cycle. Turbine research, highly developed for large jet aircraft engines, has thus far failed to produce small shaft turbines able to compete with piston Otto cycle types in cost and economy. It may come in time, but not soon. The Stirling engine has been under development in Holland for many years at Phillips Corporation, and their highly efficient machine can now be built at a weight of five pounds per horsepower. Clearly, this is not the answer to our problems just now.

On the face of it, then, there is a four-stroke in our racing future unless something radical can be done for the two-stroke to rescue it from legislated oblivion. Its problems arise from its mode of scavenging. Burned gases are cleared from the cylinder by fresh mixture, and a large part of this fresh charge mixes with the exhaust and is lost before it can be burned. This produces both heavy fuel consumption (12–17 MPG in a racing 750) and high unburned hydrocarbon concentrations.

If we could scavenge the cylinder with pure air, as is done in Diesel engines, and then inject the fuel into the combustion chamber only, the worst problems of the two-stroke would disappear and its assets would become apparent.

Such an engine exists. It is the French-built Motobecane 350 triple, equipped with electromagnetic fuel injection. On injection, it uses exactly half the fuel it requires when fitted with carburetors, yet gives the same performance. Its emissions are tiny. Injection is not simple or cheap, but then neither are all the paraphernalia of four-stroke high performance—cams, valves, gears, chains and shafts. Racing enthusiasts must hope that the mad rush to meet future EPA standards does not overlook this light, powerful, and not unduly complex alternative.

It's better to initiate change than to be dragged along in its wake. The new emphasis on suspension is refreshing, but our sport was forced to it. What we need now is a new direction for engine development as well, a new set of performance criteria that takes sensible account of the newly energy-short economies of the industrial countries.

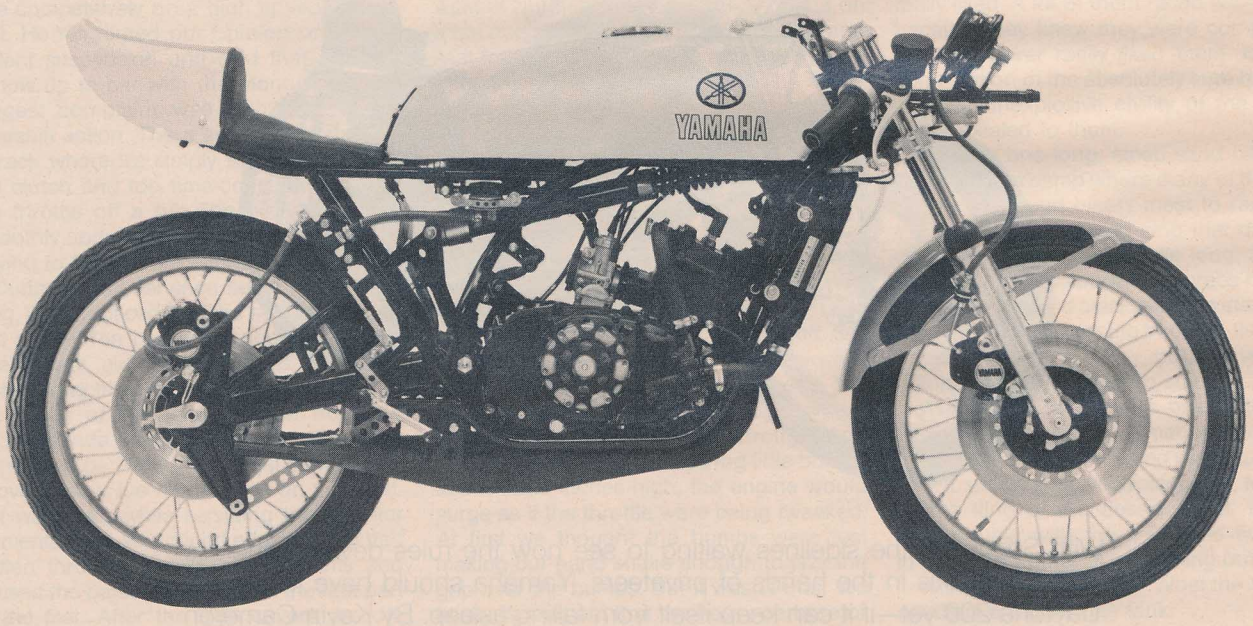
Without changes of some sort, racing machinery can become standardized to a point where it becomes only a stage prop for a conservatively managed spectacle. The 1975 racing season contained both trends. New and original work is beginning, but standardization, in the form of swarms of very fine, nearly identical Yamaha 750s, has taken a good hold as well. Which will it be? Works Yamahas won every 250 and 750 national road race this year, with similar private machines filling most of the remaining places. Yamaha's experience, their policy of selling what they race, and their mature US racing organization have put them deservedly at the top. Policy shifts, hopscotch hiring and firing and petty politics have no place here, and the Kel Carruthers racing operation remains the envy and the despair of all serious competitors.

The big Yamaha won its first Daytona as a reed valve 64 X 64 mm four cylinder 700, and has won all but one AMA national since. Enlargement of the existing casting to 66 mm bore brought the engine out to a full 750 for 1975, and there were detail improvements to other parts as well. Reliability remained at an airline-like standard.

The engine's moderate state of tune

DAYTONA PREVIEW

Yamaha's 250, the perennial Lightweight winner, was threatened in 1974 by HD's Aermacchi twin and in 1975 by the Kawasaki KR-250. Responding, the 1976 version will have an updated engine and Monoshock suspension.



allows it to deliver the widest and least violent powerband in racing. The other engines, with fewer cylinders and therefore longer strokes, must make their power with high BMEP and narrow pipe tuning. The Yamaha thrives at 11,000 RPM, a good 1500 revs higher than the competition, and can thus make the same power without resort to narrow tuning. The engine is useful from 4000, and begins serious work at 7500. A genius is not required to keep this machine on the power: thus the Yamaha four-cylinder's excellent safety record.

There are a lot of parts in this motorcycle, and not all of them are perfect. The 1976 machines will still have the flat-sided pipes that blew out so often in 1974, driving their owners to make or buy round pipes, arranged with three under the engine and one over the top of the gearbox. The clutch alternates steel and organic-faced aluminum plates. When the clutch is slipped during the start, the engine's surplus power is converted to heat in the clutch. The organic facing insulates the aluminum plates, obliging the steel plates to absorb all the heat. In many cases they warp, and even split into pieces. The rider must use care with a Yamaha clutch, while the all-metal clutches of the Kawasakis and Suzukis will take almost unlimited punishment. The 750's cylinders have proved to be more seizure-prone than those of the original 700, perhaps because the overbore has weakened the already-thin cylinder walls. When torqued between deck plates, most Yamaha cylinders measure round and straight between .0002". If hot water is circulated through the coolant passages, however, the 750 cylinders develop a .0005" bulge at each cylinder stud tunnel, enough to cause a seizure in a running engine.

Handling has been the most persistent owner complaint, and the Yamaha, with its 350 pound weight, quick steering, and unimaginative frame requires considerable chassis tuning to give all its performance. While Ken Roberts and a few other works riders had cantilever monoshock frames in 1975, with nearly seven inches of rear wheel travel, this year's over-the-counter machines will again be conventionally sprung. The long-travel set-up has solved many of the four's problems, perhaps because the original swing arm is much weaker than the triangulated arm of the monoshock. Many private owners have devised their own long travel rear suspensions as well.

For the first time, Mr. Carruthers is making a serious effort to lighten the 750. Thinwall copies of the monoshock frame are being built by C&J to be about eight pounds lighter than standard, and available to any customer. Cast alloy wheels and coated aluminum brake discs will be used as well, but it is claimed that all lightweight parts being used by the works bike will be available to the public. There will be no "unobtainium" in use. They haven't needed it in the past, and with the other companies sitting out 1976, they probably won't need it now. The probable reason for the weight-saving campaign is the stunning performance of the 300 pound Kawasaki 750 at Laguna Seca, an acceleration track where Yvon duHamel pulled away from Roberts on the Yamaha

(Continued on page 106)

until an oil spill ended his drive.

Under some pressure from Harley-Davidson in Europe and Kawasaki in the US, Yamaha has decided to update their perennially successful 250 yet again. The piston-port 54 X 54 mm twin will get a new cylinder with different port timing, a new head configuration, and new exhaust pipes based on the works item used for the past couple of years. The frame will have a monoshock at the rear, a new, 750-style fork at the front, and disc brakes at both ends. Because of generous brake parts and frame stiffening, weight will be up two or three pounds.

The droning performance by Carruthers' team 250s at Ontario provoked every kind of silly speculation, but the truth is that when time is short, the 750s will get all of it and 250s will suffer. Steve Baker's winning Yamaha Motor Canada entry displayed the performance level we normally expect from Roberts' rides, and with good reason: the engine was a prototype for 1976.

Yamaha has been building momentum in this kind of racing for ten years, and so their partial withdrawal will cost them little or nothing in success. Roberts' 750 was utterly superior at Ontario, and even unchanged, should be able to handily beat its competition. But for 1976 it should be even better. With all the new 250s elevated to the 1975 works performance level, Yamaha's hold on that class should also grow stronger.

Nevertheless, we must remember that it takes only one fast motorcycle to win any race. I am told that road racing no longer fits Suzuki's US sales image. Their US market for road bikes has never been large, and new legislation is forcing them to spend their money developing a new four-stroke line. With racing at a turning point, it makes sense for them to take a break and await developments. In Europe, where Suzuki's square-four 500 GP bike is clearly the fastest (if not the most reliable) in its class, the company has also decided to pull back, instead offering 500 replicas for privateer use in Europe, Australia, and Asia only. It will not be submitted for AMA approval.

Despite the cutbacks, there were Suzuki men and machines at the recent Indonesian GP, that scene of so much pre-season saber-rattling by Japanese companies. Clearly they are still very interested.

In 1975 they updated the three-cylinder TR-750 for the third time instead of introducing any of the all-new prototypes they have been experimenting with. This shows prudent economy and a fear that the present rules may not last long enough to make a new engine worthwhile. The TR-750 at Daytona was a very advanced machine indeed, with Suzuki's inverted lay-down shocks controlling a four pound aluminum swing arm through 135 mm of travel. A six speed gearset replaces the former five in an attempt to tame the very steep powerband (one version had 60 BHP coming in between 6500 and 7500). Large numbers of parts were drastically redesigned for lightness, including the crankshaft.

Through Daytona practice the Suzukis remained a potent force, qualifying Tepi Lansivuori in second spot and reeling off rapid trap times. Continuing problems with the lightweight parts required their replace-

ment with original material, and on race day chain stretch, as so often in the past, reduced these lovely racers to pushbikes, and the Suzuki threat dwindled away to nothing.

The rest of the season also followed unfortunate Suzuki tradition: failing to get the big win at Daytona, their interest and activity fall off. Suzuki's sixteen-year history of absolute racing department secrecy has prevented them from building up a professional racing department in the US. Winning races by remote control doesn't seem to work.

Suzuki's equipment is always well-engineered and well-ridden. The power is there. Tragically lacking is a serious attitude towards US racing, and a willingness to recognize equals among US personnel.

January, 1975 saw Kawasaki just beginning to cut and pour metal for their long-awaited line-up of water-cooled racers. Both engines were entirely new, sharing no castings with any other engine ever made by Kawasaki. The 750, a square 68 X 68 mm three cylinder piston port two-stroke, was to give a realistic 120 BHP at 9500 RPM. The 250, a 54 X 54.4 mm rotary valve twin with its cylinders arranged one ahead of the other on separate cranks, was to give a very considerable 60 BHP at 12,000 RPM. Though Daytona was a disappointment for Kawasaki's fans, indifferent performance was understandable from such new equipment. The team fought back hard all the rest of the season and brought both designs within a hairsbreadth of victory. The year's end brought a high-level decision to stop road racing and now this promising equipment has been handed over to privateers.

The new 750 was created to correct the many problems of the production-based air-cooled H2R. Water cooling would take care of overheating and detonation. Staggering the transfer ports would allow deep transfer loops and still allow the block to be narrowed 20 mm. A wider gearcase accommodated a strong six speed transmission that would permit a narrower, livelier powerband.

Oddly, however, the new engine did not take advantage of its longer stroke to provide larger transfer windows. In effect, they have carefully packaged 1972 A-type (divided exhaust and inlet port) air-cooled porting into a much smaller, water cooled block. The Yamaha 750 still has a 60% advantage in transfer port area over the new Kawasaki.

Randy Hall is responsible for the 750 in the US, and he has gotten results by hard work. Japan requires reams of reports, since the factory men believe a victory without proper documentation gets them nowhere, despite what it may do for sales. The company's history of willingness to experiment counterbalances this burdensome paperwork, and the results have been interesting. While the new 750 and 250 were having their ups and downs in pre-Daytona practice, team rider Jim Evans was testing a prototype of Kawasaki's remarkable four bar linkage rear suspension. A later version, powered by one of the new 750 engines, was run in practice at Laguna Seca and would have done battle in the race had it been possible to fit it with the latest exhaust pipes. Finally it got its chance at Ontario, where Yvon duHamel rode it into third place, a remarkable development of both engine and chassis in a single year.

The 250 had an even less-auspicious Daytona than the 750, with only one machine running in dismal 13th place at the end. Ron Pierce was added to the 250 line-up, replacing injured Jim Evans, and he began to work with 250 development man Steve Johnson to apply tried and true Yamaha privateer methods to the little twin. Their first gains came from a new exhaust pipe, which failed on the dyno but gave the team encouragement by winning a large-scale club race at Loudon. Eventually, further work on cylinder porting and head shape improved the KR-250 so much that it finished 3rd and 4th at Laguna Seca. This success was just in time, for the Japanese planners, chagrined at the 250's failure to qualify for European GPs, were on the point of ordering the entire program into the crusher. Continuing work by Pierce and Johnson jacked performance to over 52 BHP for Ontario, where Kawasaki men won both 250 heats and Yvon duHamel led the final until sidelined by frame breakage.

The 250 has been temperamental, suffering from a variety of often obscure maladies. Each problem has been dealt with in its turn and the result is a machine that has finally rattled the shutters over at Mr. Carruthers' race shop. The machines to be used by privateers in 1976 will be up-dated in every respect to the Ontario power level. While lacking the maturity of the Yamahas, they are very light and have excellent handling and braking. The factory expects to gain from the privateer arrangement in 1976 or it would not have bothered with it. There will be close cooperation between the users and the factory, and new information will pass both ways.

For a short time in 1974, after Harley-Davidson's new 250 won its first race at the Loudon National, anything seemed possible. A four-cylinder 740, based on a pair of enlarged twins, seemed only a matter of time. This honeymoon was based on the idea that the Italian subsidiary would maintain a steady flow of winning two-stroke innovations for road racing, while the US race department concentrated on its fine dirt-track four-strokes. As always, Europeans want to win European races and Americans want to win American races. The European Harley went on this year to win its second World 250 Championship while its American counterpart languished. Parts were few, and the privateers who had bought the 1974 machines were complaining loud and long.

Overtures were made to well-known US two-stroke tuners, but no one was trading in his independence for a sergeant's stripes in Harley's four-stroke army. The dirt machines went from strength to strength, and Gary Scott won the Number One Plate without road racing points. This has influenced planning in Milwaukee, for road racing is very expensive, clearly a bad investment if the number one plate is the only goal. Consequently Harley's only weapon for the big class is the Italian-built 500 reed-valve two-stroke twin. The four-stroke vee-twin won its last race here in 1972, and can no longer reach a satisfactory performance level.

(Continued on page 108)

Despite really promising pre-season performances in 1975, the 500 twin soon settled into mediocrity. On paper, its 90 BHP and low 280 pound weight put it in the same class as the 750s, but its first US run at Laguna Seca was unimpressive. To get enough airflow from available reed boxes, two were used on each cylinder, each with its own carburetor. A transmission-mounted disc brake reduced unsprung weight at the back. This machine has run quickly before, in the hands of the men who made it, but surely Harley is learning the lesson that the rest of the industry knows so well: it's not easy to succeed with racing equipment that you don't build yourself. There is, obviously, plenty of available talent in the US, but as long as two-strokes are regarded in Milwaukee as a dangerous plague, Harley will have little success with them.

Last year saw a limited war fought out between two concepts of racing tire design. The Goodyear slick operates at a high temperature of 285° F, because its very flexible casing and slick tread generate a lot of heat. A very thin layer of remarkably strong, temperature-tolerant rubber is used on a nylon casing, and the combination lays down a large and uniform footprint that keys well with the road surface. To further combat wear, the rear tire is of great width, nearly six inches. Dunlop, using a less temperature-tolerant rubber, was obliged to reduce heat build-up by using a much stiffer casing built on a synthetic aramid fiber. A larger thickness of rubber was necessary to give the required tire mileage. The rear tire is also of maximum width, at six inches. Both makers experienced troubles with their own concepts, Goodyear having to make their 5 pound 250 tire stronger, and Dunlop having to re-examine the whole concept of the stiff casing.

Each maker has specialized in his own area of special competence. Goodyear makes the best tire for our usually dry, hot conditions, on tracks often surfaced with high-traction asphalt. Dunlop, whose tires are still very good in US racing, are completely dominant in Europe, where tracks are often abrasive and races are run regularly in rain and cold weather.

A further item of interest is that this past year has seen a real split in the requirements of national competitors and club racers. Tires for Ontario simply do not work at a rainy, cold club race at Bridgehampton. Modern racing tires depend upon their tread rubber reaching a certain temperature for maximum grip, and this is not always possible in cold weather.

With the factory team cutbacks, there will be tire company cutbacks. The rapidity of development will slow, and this is appropriate now, for new knowledge can be consolidated with time.

To sum up, we have a momentarily poor situation in racing, with only four nationals planned in 1976, and greatly reduced participation by the factories. Everyone expects changes to come and design offices are full of interesting possibilities. While this pregnant pause approaches term, Yamaha is still strong and Ken Roberts' contract has another year to run. He will, as usual, make it worth their money. He always has. ◉